Influence of Islam on Western Civilization

PROF. ZIAUDDIN AHMAD

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FOREWORD

It is now widely recognised in academic circles that the great civilization engendered by the conversion of the Arabs and others to Islam had a profound influence upon the peoples of Europe. Indeed this was inevitable when a great awakening took place on the southern littoral of the Mediterranean and when those who were the beneficiaries of this awakening were quickened into political, commercial and navigataerial activities. On two sides of the Mediterranean, the Moors and the Turks crossed over into Europe and established great empires on European lands. Similarly, Sicily became a dynamic centre of Islamic activity which spread into southern Italy. The Venetians, sticking to their Catholic faith, developed into a great commercial community that not only carried the goods brought by the Muslims from the fabulous East but also the knowledge that had been brought together and developed in Muslim lands.

The knowledge of these facts has been widespread, but the depth of the infiltration of Muslim ideas and learning has not been so easily available. European historians have ever been chary in acknowledging it. On the other hand, even learned professors in Western Universities have always rejoiced in the fact that the advance of the Moors into France had been effectively checked. They seldom mention the fact that the result was that ignorance and superstition received a much longer lease of life in Europe. Only when Islamic learning spread through the Universities of Spain and Sicilian Arab scholars began to adorn Christian courts of Italy, did the darkness begin to decrease.

The Mediterranean Sea, because of its comparative narrowness and consequent freedom from violent storms has, throughout history, been more a medium of exchange of ideas and knowledge than a barrier. It did not and could not possibly have played the roles of the Atlantic and Pacific Oceans in isolating the land whose shores it washed, from each other. The Mediterranean Sea has been navigable and at its widest points islands and thrusts of land like that of Italy have brought North Africa and South Europe within easily navigable distances of each other. Commerce of commodities and ideas has been common and the rise of Islam and the quickening of enterprise in the Southern lands made it more extensive. Earlier, Carthage had offered such a challenge to Rome that it "had to be destroyed". But Carthage was only a city, even though it was pitted against another city, Rome. The Muslims were quite a different matter. They were more numerous, better organised and possessed vast territories.

With the rise of European power the tables were completely turned, but that story is not relevant to this book. It has, however, to be mentioned in a different context. The Muslim influence over Europe was considerable and embraced many facets of life, but it was never so pervasive and enervating as Western influence has been upon the Muslim lands. The Europeans did not lose their sense of entity or culture; they never cultivated the deep psychosis of an inferiority complex which ails the Muslim world today and inhibits both originality and effective action.

Mr. Ziauddin Ahmad has rendered a real service by arranging so valuable information scattered, unequally, in so many places together into one handy and readable volume. It will be of great benefit to all Muslims in reminding them that they were not always at the receiving end of the inevitable line of communication and will also enlighten the average

reader of the West regarding some of the sources of his culture and progress. Hitherto the average Westerner generally recognises only the Judo-Christian tradition and Greece and Rome as his benefactor; he must give a place to the achievements of Islam as well in his intellectual pantheon. This will be a potent instrument in breaking down hostility and erecting tolerance between neighbours who have so much in common without realizing it.

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PREFACE

An objective study of the history of science reveals that it was during the heyday of Muslim civilization that we turn to a new page in history. The Muslims not only kept alive the memory of Greek learning but also made a considerable original contribution to our knowledge of nature with their researches and experiments through astronomical observatories established in various parts of the Empire. Among the most outstanding scientists, Hassan al-Rammah shines as a star of first magnitude. He is credited with inventing rockets, which laid the foundation of the science of rocketry and ushered in the space age. As there is dearth of literature on his researches and wonderful contribution to the space probe no more light could be thrown than given in this book elsewhere.

There is no doubt that with complete dedication and ardent devotion to scientific research and experiment the Muslims made a marvellous contribution to human civilization. Undoubtedly, modern civilization is the outcome of the concerted efforts of past human geniuses. Since the days of the Greeks, the human mind has moved forward on the path of discoveries, inventions and scientific and technological developments. The Muslims, with their intellectual supremacy in art, practical discovery and physical sciences prepared the ground for the Renaissance and opened the flood gates of treasures of knowledge.

The real aim of this book is to stimulate our younger generation to work with devotion and integrity and not to gloat over their past glories and achievements, in order to excel in their scientific researches and

experiments and march shoulder to shoulder with the scientific and intellectual giants of the modern world.

I should be failing in my duty if I do not express my gratitude to Dr. Ishtiaq Husain Qureshi, an outstanding scholar and historian of international repute, for very kindly writing a thought-provoking and learned foreword to my book.

To my learned friend, the late Dr. Mahmud Husain, an eminent scholar and historian, I am deeply beholden for providing great encouragement and valuable advice.

I am indebted to Dr. Shafqat Husain Siddique and Mr. Mohammad Abdus Subhan Khan for their valuable advice and suggestions.

My thanks are also due to Mr. Bazmi Ansari for going through the whole manuscript and giving great help and guidance.

I am deeply grateful to my wife, Aziza Begum, for displaying great patience and determination to help me in the accomplishment of this task.

ZIAUDDIN AHMAD

Karachi :

October, 1978

RESURGENCE OF A NEW SPIRIT

INTRODUCTION

RESURGENCE OF A NEW SPIRIT

Muslim culture is a subject of paramount importance which needs the attention of scholars in Pakistani and other Muslim universities to discover the still unexplored treasures. In almost all the universities of Europe and North America there are faculties and bureaus for research and inquiry and in Egypt a great deal has been done in this respect. There are studies in English, French, German, Italian and Russian, and in Arabic and Turkish that reveal vast treasures of intellectual progress and achievements of the Muslims.

There is no doubt that a study of the evolution of civilization brings before us a wonderful unity and variety of Islamic culture. The unity and diversity are the results of historical expansion of Islam in the world with distinguishing marks of three waves of expansion. The sponsors of the first movement were the Arabs who moved onward in the seventh century A.D., with their torch of knowledge and learning, from the Atlantic in the West to the Oxus and the Indus in the East.

In the great centres of learning during the hey-day of Islamic civilization in Europe, in Cordova, Granada and Seville, students flocked from various corners of the world to slake their thirst for knowledge. They were much impressed by the new researches and discoveries of the Muslims and their disciplined observations of nature; laboratories for detailed analyses and experimental testing of hypo-

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theses; systematic use of scientific and scholarly literature; critical evaluation of the work of colleagues; a dedication to, and an elaboration of the methods for investigation into the nature of the universe and of human phenomena.

This inductive and experimental method of research and inquiry and the critical spirit exercised a far-reaching influence and created tremendous confidence on the oncoming generations of Europe and other countries, who subsequently built up the noble structure of their educational edifice on the foundations laid by the Muslims in Europe. The inspiration given by the Muslim universities ultimately led to the setting up of numerous colleges in Europe imbued with the spirit of scientific approach to knowledge.

Dr. Tara Chand, a distinguished scholar and historian of India, has rightly remarked, "For a thousand years this civilization was the central light whose rays illumined the world. It was the mother of European culture, for men reared in this civilization were the masters in the Middle Ages at whose feet the Spaniards, the French, the English, the Italians and the Germans sat to learn philosophy, sciences of mathematics, astronomy, chemistry, physics, medicine and industrial techniques. Their names are household words."*

The first movement ended with the waning power of the Caliphate in the tenth century. Then the second wave of expansion spread in the eleventh century under the leadership of Persianised Turks who carried Islamic civilization towards the East, extending it to the Indo-Pakistan subcontinent. They were savants of Persian language and literature deeply imbued with fine literary and artistic culture, and the rich traditions of social and political behaviour. With them came a galaxy of scholars or *ulama* who were steeped in Arabic and Islamic lore. They exercised tremendous

*Presiden ial Address, Fourth All India Islamic Studies Conference, 25-27 December, 1964, Osmania University, Hyderabad (Deccan), p. 23.

influence as the *Fuqaha* or jurists for the dispensation of law and justice.

The political expansion of Islam to some extent weakened its homogeneity and solidarity. The coherence slowly declined with the non-recognition of the spiritual headship of the Caliph. The hegemony of the Caliphs was shattered by the onslaughts of Halaku in 1258 A.D. This led to the rise of independent dynasties like the Tahirids (821—873), the Suffarids (867—903), the Samanids (875—999), the Ghaznavids (962--1186), and the Buwayhids (932--1055). Ghayasuddin Balban, Muizuddin Kaiqubad and Jalaluddin Feroz Shah even struck coins in their names under the spiritual title of *Al Imam al Mustasim Amirul Mominin* only twenty years after the fall of Baghdad.

The fourteenth and fifteenth centuries brought in their wake the third wave of expansion and culminated in the establishment of three great Empires—the Ottoman in the West, the Safavid in the Centre and the Mughal in the East—besides the Sultanates of Malaya and Indonesia in the Far East. The signs of disintegration crept in and each Muslim State worked independently of the other. After the transfer of the Caliphate to Constantinople (Istanbul) in 1517 A.D., the Mughal Emperors assumed greater independence to recognise the Ottoman Caliphs and had the *Khutba* read in their names. This sapped the foundations of the Muslims as a world Power and they receded from their impregnable sublime position. The rise of European seapower in the seventeenth and eighteenth centuries also arrested the progress of Muslim advancement, drove their fleets from the sea, disrupted their solidarity and dealt a blow to their economy, commerce and trade.

But the advent of the nineteenth century reawakened the Muslims and produced a movement for the revival of Islamic unity. There arose a band of selfless and devoted reformers and thinkers like

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What do we see today? Young, vigorous and progressive Muslim nations are on the march again. While maintaining their national identity, they are concerned about the weakening of the bonds of the *Millat*, the world community of the Muslims. Islam, which literally means peace, can be a dynamic force in the establishment of the unity of mankind and the abolition of exploitation and war.

The evolution of a number of diverse nations in the Islamic world is not a matter for despondency; it is rather a healthy sign of progressive evolution. Individualism is the basis of integration, and the higher the quality of individualism, the sounder integration is likely to become, more so, in case of ideal constructs such as society, state and humanity.

There is no denying the fact that it takes more than physical and human resources to develop the strength of a nation. It takes the ability of the people to apply their knowledge for full utilisation of what they have, to the best advantage of the entire nation. There are five factors that contribute to national strength, three of them of prime importance: (i) human resources, (ii) economic resources, and (iii) the development of know-how for the proper utilisation of the other two factors.

Then comes the most important factor, the political resources, which means the existence of a political ideal and a proper environment for its development. These are inter-dependent and demand that the society in which we live should be relatively free and stable.

There is a fifth factor without which no nation can ever be considered, in the real sense, strong and stable. This is the resource of morality. The earnestness and forcefulness with which a nation applies its moral strength and will to the solution of national and international problems is one of the most important measures of the true strength of a nation.

The understanding of economic and social reality in the face of the complexities of modern life is a difficult task. The test of real understanding of democracy and its laws is responsible civic action. It demands active participation in the national life, the problems of the society and a willingness to work with other diverse religious and racial groups for the common good of the country. The racial, religious, linguistic and ethnic diversity of the State require that culture, education, refinement and the way of life should carry the individual beyond the family and racial group into a full membership of the nation and make him a productive worker in an open and fluid society based on the international outlook of society and State. Edmund Burke, the great English political thinker, has rightly said, "To be attached to the sub-division, to love the little platoon we belong to in society, is the first principle of public affection. It is the first link in the series by which we proceed towards the life of our country and to mankind".

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society. Even nations not richly endowed by nature have much leeway to make. The highways of modern science and technology are open to them. They have to catch up with the advanced nations in constructive and purposeful technical endeavour for their complete scientific and economic development deeply rooted in self-reliance ard self-confidence.

To achieve these ideals, knowledge should be encouraged at all levels of society and the mental development of the masses should advance with gigantic strides. The spirit of progress ard the noble idealism give real life to a nation. The thirst for knowledge, research and inquiry can raise nations to great heights in the scale of scientific ard cultural excellence. This will produce thinking citizens, creative scholars and virile soldiers and promote scientific research to their utmost possible degree and advance them to prefection.

CHAPTER 1

Expansion of Islam

Four years after the death of Justinian, who had put an end to philosophy in Greece, Prophet Mohammad (peace be upon him) was born at Mecca, in 571 A.D.

A member of the noble family of Quraysh, by the time he attained the age of twentyfive, he became well-known for his integrity and honesty which earned him the title of '*Al-Amin*' (the honest and upright). After the age of thirtyfive, he spent most of his time in solitary meditations in a cave, called Hira in *Jabal-un-Nur* (Mount of Light), a hill about three miles north-east of Mecca. It was during the course of his meditations in this cave that one night he received the divine revelation, "Recite thou in the name of thy Lord who created" (the whole universe), which gave him spiritual illumination on the truth of Tauhid (Monotheism) and conveyed the message that God had chosen him to be His messenger.

The momentous revelation opened a new chapter in the history of mankind. Henceforth, the Prophet's life was entirely spent in weaning Arabia from idolatory. The fruits of his labour were gathered even during his lifetime. The greatness of the Prophet lies in the tremendous force and enthusiasm with which he imparted his creed which may be called the rationalistic religion of Islam.

The Saracenic Conquests

The concept of *Tauhid* cemented the Arabs into one nation, which they had never been before, and the

country quickly left its "Age of Ignorance" far behind. Moreover, the domination of the world was soon to pass over into the hands of the Arabs whose chief traits were bravery, truth, munificence, characteristic high-mindedness and hospitality.

On the death of the Prophet Mohammad (June 8, 632 A.D.) the Muslims were governed in turn by four of the most eminent among his companions, Abu Bakr (632-34), 'Umar (634-44), 'Uthman (644-56), and 'Ali (656-61).

Soon after the assumption of office of the Caliphate by 'Umar the Saracenic conquests began. At Damascus the Roman army was defeated (September 635). Heraclius saw the complete overthrow of his Roman army at the battle of Yarmuk (August 636), which caused him finally to abandon Syria.

Jerusalem was the next objective. Caliph 'Umar journeyed from Madina to take formal possession of that historic city in 638. Tripolis, Tyre and Caesarea fell next. The sailors of Phoenicia equipped the Saracenic fleet which drove the Roman navy into the Hellespont. The Arabs now gained the command of the sea. Cyprus (649) and Rhodes (654) fell and the army of the Caliph lay in front of Constantinople, but it was not till the year 1453 that the Turks captured it. During the time of the conqueror of Jerusalem, all Syria from south to north was completely subdued. The fate of Persia was settled at the battle of Qadisiyah (June 637) which forced the Persians to abandon all their western possessions and withdraw to Persia proper leaving the Muslims the masters of Iraq, including the Persian capital of Ctesiphon on the Tigris. In 635 Damascus had already fallen, and Caliph 'Umar had established two new cities of Basra and Kufa, which became great centres of learning and knowledge.

The last of the Chosroes was defeated in the battle of Nihavand (641). Magianism received a heavy blow. The country beyond the Oxus was reduced.

We next see the banner of Islam flying on the bank of the Indus, and the Emperor of China seeking the friendship of the Caliph at Madina. The Caliph now turned his eyes further to the West. Memphis soon fell and Alexandria was invested. After the capture of this famous city of the Ptolemies by the veteran troops of Syria, the Saracenic movement took an intellectual shape. Egypt was the material and spiritual stronghold of the Byzantines, and when Heraclius received the sad news of the fall of Alexandria (646) in his palace at Constantinople, the emperor was so overwhelmed with grief that he lived scarcely a month after the fall of the city. It was not the intention of the Caliph to limit his conquests to Egypt. 'Uthman, the third Caliph, contemplated the annexation of the entire North African Coasts. His General 'Abdullah set out from Memphis and besieged Tripolis. Twenty years afterwards, the Muslim army forced its way from the Nile to the Atlantic.

The Caliph Abdul Malik resolved on the reduction of Carthage (*Qartajannah*). His general conquered the great rival of Rome. The captured Christian capitals numbered three by now: Jerusalem which was the birth place of Christianity; Alexandria which was the home of Greek Christianity and, lastly Carthage, the home of St. Augustine and of Latin Christianity. In little more than one generation all the population of North Africa had become Muslim and their children were speaking Arabic. The new religion conferred upon the converts a sense of dignity, self-reliance and self-respect with which they had been totally unfamiliar. It gave hope to the so-called slave, and a wonderful sense of brotherhood to its followers, a brotherhood which allowed the water-carrier of the Caliph to stand on the same prayer mat on which stood his master to pray with him to God.

The Invasion of Europe

The Caliph Al-Walid next authorised the invasion of Europe, and the conquests of Andalusia. Musa

ibn-Nusayr, ably aided by his lieutenant, General Tariq, pushed northwards and finally completed the reduction of the Spanish Peninsula in 711 A.D. But for Charles Martel, the Muslims would have run over the whole of France also. A study of the Muslim conquests shows how large a measure of their success was due to the marvellous enthusiasm that had its roots in their religion.

In only ninety years time, the Umayyads created an empire for Islam. In succeeding years the Islamic Empire grew stronger than it ever was. By 732 the Muslim conquests had reached its apogee. It had an expanse which neither the empire of Alexander nor that of Caesar or Napolean had ever attained. The Caliph of Damascus had his lieutenants beyond the Oxus and the Pyrenees on the shores of the Caspian and in the Valley of the Nile.

The Abbasids (750—1258)

Hitherto the Arabs had played a dominant role in the Muslim community. Now the tables were turned. We pass from the period of Arabian ascendancy to one of Persian ascendancy, or Persianised 'Abbasids and cosmopolitan culture. Al-Mansur, the Caliph, transferred the seat of Islamic Government to Baghdad. It was not a mere casual circumstance that the Abbasids favoured the Persian element and they transferred the seat of Government to where it was in olden times under the Achaemenids, Arsacids and Sasanids, in the plains of the lower Euphrates and Tigris. Damascus could never have suited them. Al-Mansur established schools of medicines and law in Baghdad. His grandson Harun Al-Rashid (786—809) placed all his schools under the superintendence of a Nestorian and ordered that to every mosque in his dominion a school should be attached. But the golden age of Arab learning was during the Caliphate of Al-Mamun (813—833) A.D. He made Baghdad the centre of science and learning, collected great libraries,

and surrounded himself with learned men. Under the influence of Indians, Greeks, Nestorians and Jews, the Arabs advanced in the realm of science and philosophy as quickly as they had overrun the provinces of the Roman Empire. In less than a century after the death of the great Prophet of Arabia, the works of the chief Greek and Indian philosophic authors had been translated into Arabic. It must be borne in mind that the Arabs cultivated science after the manner of Alexandrian Greeks, that is, they preferred the inductive method of Aristotle, as suiting a young and virile race, to the reveries of Plato.

The mainsprings of Muslim learning and science were the teachings of the Prophet Mohammad who emphasised the search for knowledge to harness the forces of nature for ameliorating the lot of suffering humanity. The Prophet said: "Teach science: whoever teaches it fears God; whoever desires it adores God; whoever speaks of it praises God; whoever diffuses it distributes alms; whoever possesses it becomes an object of veneration and respect. Science preserves us from error and from sin; it illuminates the road to Paradise; it is our protector in travel, our confidence in the desert, our companion in solitude. It guides us through the pleasures and the sorrows of life; it serves us alike as an ornament among our friends and as a buckler against our enemies; it is through its instrumentality that the Almighty raises up those whom he has appointed to determine the good and the true. The memories of such men are the only ones which shall survive, for their noble deeds will serve as models for the imitation of the great minds that shall come after them. Science is a potent remedy for the infirmities of ignorance, a brilliant beacon in the night of injustice. The study of letter is as meritorious as fasting; their communication is not inferior in efficacy to prayer; in a generous heart they awaken the most elevated sentiments, to the wicked they impart the corrective and humanising precepts of virtue."

CHAPTER 2

The Splendour of Baghdad

A splendid and glorious life was that of Baghdad in the days of the Abbasids when their capital had risen to its zenith. The centre of civilisation was then in the metropolis of the Muslim Empire, a capital exceeding by far the splendours of Rome. And Baghdad was essentially a city of pleasure, a Paris of the 8th century. Baghdad, the *Darul Islam*, was a worthy successor of Babylon and Nineveh, which had outrivalled Damascus and possessed unrivalled advantages of site and climate. It was a city of palaces and government offices, hotels, pavilions, mosques and colleges, of kiosks, and squares, bazars, markets, pleasure grounds and orchards adorned with all the graceful charms of Arab architecture which had blended different cultures retaining their own individuality. Grand edifices spread along the banks of the Tigris under a sky of marvellous purity and in a climate which makes life a luxury. It was surrounded by far-extending suburbs and villages, dear to the votaries of pleasure. With the roar of a gigantic capital mingled the hum of prayer, the carolling of birds, the thrilling of harp and lute and bewitching strains of the professional singers, poets, wits and dancers. The splendour of the capital kept pace with the prosperity of the Empire. Within a short time, from a fortress it grew into a world centre of fabulous wealth and glory standing aloft as the only rival of Byzantium. It was then that Baghdad became a city with no peer throughout the whole world.

"Along Baghdad's miles of wharves lay hundreds of vessels, including ships of war and pleasure craft varying from Chinese junks to native rafts of inflated sheepskins, not unlike those of our present day, which were floated down from Mosul. Into the bazaars of the city came porcelain, silk and musk from China; spices, minerals and dyes from India and the Malaya Archipelago; rubies, lapis lazuli fabrics and slaves from the lands of the Turks in central Asia; wax, furs and white slaves from Scandinavia and Russia; ivory and gold dust from eastern Africa. Chinese wares had a special bazaar devoted to their sale. The provinces of the Empire itself sent by caravan or sea their domestic products: rice, grain and linen from Egypt; glass, metal ware and fruits from Syria; brocade, pearls and weapons from Arabia; silk, perfumes and vegetables from Persia".[1]

Such was Baghdad, and who could have thought in those days that this great city would one day be pillaged by Halaku and later on by Taimur, the Lame.

Magnificence of the Caliphs

Arab princes and their great men have been famous for their liberality to men of science and learning. Harun al-Rashid used to pour water for a blind man to wash his hands, because he was one of the most learned persons of his time. It is related of Abdul Malik who ruled towards the close of the first century of the Hijri that when on one occasion a learned man elegantly informed him of an error of some kind or other, he ordered his mouth to be filled with pearls. These, he said "are things to be treasured up, not to be expended", and for this delicate hint he was further rewarded with 30,000 pieces of silver and several costly articles of apparel. The following striking record will convey an idea of the magnificence and liberality of a Muslim Prince, and at the same show how severely even the highly placed officials were used to be

[1] A Short History of the Arabs, Hitti, p. 87.

punished for crimes. A person looking at a register kept by one of the officers of Harun saw in it the following entry: "Four thousand pieces of gold, the price of a dress of honour for Jaffer, the son of Yahya, the Vizier". A few days later he saw below this entry written: Ten Karats, the price of naphtha and reeds for burning the body of Jaffer, the son of Yahya". The end of Jaffer, the Barmecid (Barmakid) was like that of Buzerchemehr, the vizier of Naushirwan, the Just.

Literary History of Baghdad

To dwell at length on the literary history of Baghdad would amount to writing a history of Muslim Science and Literature. Sedillot did not exaggerate the truth when he said that from the beginning an essentially scientific character was the marked feature of the school of Baghdad. To accept nothing as truth what was not borne out by experience and experiment was its cherished aim. The literary history of Muslims cannot be dismissed without a passing reference to that most singular society called *Ikhwan-al-Safa* (the Brethren of Sincerity) which consisted of 40 members, a curious anticipation of the French Academy. The transactions of this unique society have thrown a flood of light on the literary and scientific aims of the Mussalmans. Prof. Dieterici laboured indefatigably in unearthing its forgotten treatises and translating the *Rasail* (Epistles) in 16 volumes. The Professor goes so far as to say that the "forebodings of even the Newtonian law of gravitation are found among the Arabs".

To Harun al-Rashid must also be given much of the credit for that liberal encouragement of letters, arts and science which made the Court of the Abbasids the centre of the highest culture, to which the learned and the gifted flocked from East and West.[1]

1. E. Denison Ross, Islam, p. 25 (London, 1928).

CHAPTER 3

Break-up of the Islamic Empire

After the death of Harun al-Rashid (809), the Muslim Empire began to disintegrate slowly. The unity of Islam, in political sense, was now destroyed, but out of the chaos which ensued, three Muslim Empires, the Turkish, the Persian and the Mughal, gradually took shape in the East.

About the year 1000 A.D. the Islamic Empire was in a process of decay. The Turks arrived not a moment too soon. Their timely conversion proved a boon to the cause of Islam. They revived the old dreams of the conquest of Constantinople and supplied the element of vision which was so sadly lacking in the Islamic body politic at that time. In 1358, the Turks (Othmanlis) crossed the Hellespont and established a garrison in Gallipoli. This was the first step in the conquest of Byzantine Empire in Europe; by the end of the 14th century these Turks were in possession of the Balkan peninsula. In 1453, Murad's son, Mohammad II, conquered Constantinople, which had been till then the home of Greek and Latin scholarship. In that year the scholars, taking with them their books and manuscripts, fled to Italy where they were warmly welcomed. It was from Italy that the New Learning spread to Europe and to England.

We are not concerned with the Persian dynasty of Ispahan and the Mughal dynasty of India here but a brief mention may be made of Ismail who, at the instigation of the Caliph in 903 A.D., drove the Saffarids out of Khorasan and became ruler of all the Persian

provinces gained by Yaqub ibn Laith. Under this prince and his successors, Samarqand and Bukhara became the centres of civilization, learning, art and scholarship for a large part of the Muslim world.[1]

Civilisation of the Spanish Arabs

The discord between the Omayyads, Fatimids and Abbasids caused by deep-seated tribal jealousies resulted in the tripartite division of the Muslim Empire in the 11th century into the Caliphates of Baghdad, Cairo and Cordova. The Abbasid dynasty in Asia, the Fatimids in Egypt and the Omayyads in Spain became rivals, not merely in politics but also in letters and science. The Fatimid Library in Cairo had about 100,000 books while the number of books in the great library of the Spanish Caliphs was 600,000, their catalogue alone consisting of 44 volumes.[2]

Having crossed the straits of Gibraltar, the Arabs continued to carry out the precepts of the Prophet of Islam and kept alight the torch of learning. Scarcely had they firmly settled in Spain, they embarked upon a brilliant literary career. In Art and Science the Caliphate of Cordova rivalled, if it did not outshine the glory of Baghdad.

1. E. Denison Ross, Islam, p. 41, Ernest Benn Ltd., London, 1928.
2. Al-Maqqari, Vol. 1, pp. 249-250 and 256.

CHAPTER 4

Cordova : The Brightest Jewel

Under the administration of the Arabs, and at its peak of prosperity Cordova became a beautiful city of palaces and gardens. Al-Maqqari says that with its 113,000 homes, 21 suburbs, 70 libraries and numerous book-shops, mosques and palaces, it acquired international fame and inspired awe and admiration in the hearts of travellers. After sunset a man might walk through its solidly paved streets in a straight line for ten miles by the light of public lamps whereas, according to John W. Draper, "Seven hundred years after this time there was not so much as one public lamp in London, and in Paris, centuries subsequently, whoever stepped over his threshold on a rainy day stepped up to his ankles in mud."[1] Other cities as Granada, Seville and Toledo considered themselves rivals of Cordova.

The palaces of the Caliphs were magnificently decorated. They stood forth against the clear, blue sky. They had overhanging orange gardens and courts with cascades of water. The walls were adorned with arabesques. Huge chandeliers hung from the ceiling; the apartments of the Sultans were sometimes incrusted with lapis lazuli.

The University

The University of Cordova was a great fountain of learning where thousands of students flocked to slake their thirst for knowledge. A number of institutions were affiliated to this University. Education was

1. A History of Intellectual Development of Europe, London, 1910, Vol. 11, p. 31.

almost compulsory and universal. There were 800 public schools frequented by all without any racial or religious distinctions, including Muslims, Jews and Christians alike.

The Universities of Granada, Seville and Cordova were held in high esteem by the scholars of Asia, Africa and Europe. The curricula included the teachings of the Quran, the exact sciences, medicine, music, poetry and art. The chairs of the faculties were occupied without discrimination by the Muslims, Jews and the Christians. Degrees were awarded after the successful completion of their courses. In the department of medicine a stiff and prolonged examination was held to judge the merit. All candidates who passed the test received the degrees (*Ijaza*) of professional practice, and those who failed were declared incompetent. The great scholars composed voluminous treatises on surgery and medicine.

Alhambra

The Alhambra, the world-renowned palace made of red stucco, is regarded as the best specimen of the Moorish architecture. The delicate lace-like effects produced in the 14th Century by the builders of Alhambra are supposed to have been made by pulverized marble, lime and gypsum, mixed in certain proportions with the white of eggs and then, while in an almost fluid condition run into moulds. The furniture was of sandal and citron wood, inlaid with mother of pearl, ivory, silver or relieved with gold.

Diminutive colonnades surmounted by delicate engrailed arches, medallions, festoons and wreaths, the armorial bearings and mottoes of the Alhambra, Arabic texts and legends which can be read from right with facility and geometrical designs, are the salient points which strike the eye and appeal to the imagination.[1]

1. Moorish Spain, Enrique Sordo.

The Alhambra, the outcome of the engineering skill and genius of seven centuries of Moorish progress, is the crowning triumph of that epoch. The construction is undoubtedly without precedent. It is, according to S. P. Scott, this irregularity, this independence of arbitrary and inflexible principles of art, that constitutes its greatest charm. The famous Arabian palace is the masterpiece of the Moorish architects of Spain; the remarkable achievement of the labours of 20 generations, the embodiment of the most elegant conception of the art, the industry and the intellectual culture of that polished age.[1]

All this was the outcome of the great importance attached by the Arabs to the practical application of the principles of science and technology. Their selfless devotion, research and study in mathematics raised them to the pinnacle of proficiency and contributed to a great extent to architectural improvement and perfection. The application of algebra to geometry immeasurably facilitated the development of every art dependent upon mechanical and mathematical conditions, and none is more indebted to it than architecture. Advanced training in architectural engineering was imparted in the schools of Cordova, Seville, Valencia, Malaga and Toledo. Students had to learn geometry, trigonometry, drawing and other allied branches of mathematical sciences pertaining to architecture. The lessons in all these subjects were supplemented by practical demonstrations of the application of their principles under the guidance of highly experienced and talented teachers. These institutions laid the foundation of training in architecture and engineering on scientific lines and paved the way for engineering colleges and universities in the West.

1. The Moorish Empire in Europe, S. P. Scott, Vol. III, Chapter XXIX.

Centre of Culture

Of Cordova, with a population of one million human beings, Lane-Poole writes: "Beautiful as were the palaces and gardens of Cordova, her claims to administration in higher matters were no less strong. The mind was as lovely as the body. Her professors and teachers made her the centre of European culture; students would come from all parts of Europe to study under her famous doctors, and even the German nun Hrostsvitha far away in her Saxon convent of Gaudersheim, when she told of the martyrdom of Eulogius, could not refrain from singing the praises of Cordova, the brightest splendour of the world. Every branch of science was seriously studied there, and medicine received more and greater additions by the discoveries of the doctors and surgeons of Andalusia than it had gained during all the centuries that had elapsed since the days of Galen. . Astronomy, Geography, Chemistry, Natural History, all were studied with ardour at Cordova; and as for the graces of literature there never was a time in Europe when poetry became so much the speech of everybody—when people of all ranks composed those Arabic verses which perhaps suggested models for the ballads and canzonettes of the Spanish minstrels and the troubadours of Provence and Italy. No speech or address was complete without some scrap of verse, improvised on the spur of the moment, by the speaker or quoted by memory from some famous poet."[1]

The French thinker, Renan, expresses his appreciation in these words: "The taste for science and literature had, by the tenth century, established, in this privileged corner of the world, a toleration of which modern times hardly offer us an example. Christians, Jews and Muslims spoke the same tongue, sang the same songs, participated in the same literary and scientific studies. All the barriers which separated the various

1. The Moors in Spain, p. 144.

peoples were effaced; all worked with one accord in the work of common civilisation. The mosques of Cordova, where the students could be counted by thousands, became the active centres of philosophical and scientific studies."[1]

The influence of Muslim Spain on European literature, philosophy, science and culture was extensive. The refined society of Cordova prided itself on its gay culture. Its influence spread from the beautiful Moorish lands to the territories beyond the mountains. The south of France echoed to the music of Moorish strains and instruments. Even in Italy and Sicily the love song became the favourite composition and out of these genial but non-orthodox beginnings the romance literature of modern Europe arose. Muslim Spain inaugurated the age of chivalry and her influence passed through Provence into the other countries of Europe giving birth to a new genre' of poetry and a new culture.

1. Averroes etc. Averroism by Renan, p. 4.

CHAPTER 5

Channels of Influence

The chief media through which Muslim civilisation was transmitted to Europe were Spanish teachers and traders and the Muslims of Sicily and Africa. There were also other channels through which the Muslim influence infiltrated into Europe. The material and cultural improvements that the Muslims made were very necessary for the happiness and well-being of Spain. The Christians reoccupied their country and eventually turned Muslims out of Europe but Muslim culture and civilisation continued to influence every aspect of European life. This influence was not only due to proximity, but also to the common interests of Christians and Muslims, especially to the Christian slaves, who, escaping and on their return home, nearly always retained their Arab names and culture. Between the Christians and the Muslims, visits were frequently exchanged and mutual succour given in time of civil war. Throughout the later wars the combatants on both sides were apparently a combination of Muslims and the Christians. European Muslims traded with Christian countries both by land and sea. Their goods were purchased by Christian customers in every large town in Europe. In their daily contacts Muslim and Jewish merchants taught the Arab manners and customs to their Christian customers. They intermarried not only in the lower but also in the higher strata of society. "Spanish ladies of the highest rank, among them the sister of Palagius and the daughter of Roderick, contracted marriage with the

'Infidels,' as the orthodox Jean Mariana calls the Moslems".[1]

Far from despising the customs of their subjects, Muslims had accepted the conquered, in the beginning of their expansion, as their intellectual masters; but later, in Spain as in other countries, the case was exactly reversed. The pupils became the masters of their own teachers. Spain, with its universities at Cordova, Seville, Granada, Toledo and Valencia, was the most important place of learning during the Middle Ages. Here students flocked from Europe, Africa and Asia. From the tenth century onward everyone in the West, who had any taste for learning, turned to Muslim Spain. The Jews found ample opportunity for the cultivation of knowledge under the Muslims of Spain. Learned Jews like Ben Ezra, Jonah Ben Gannach, Maimonides Bechal and David Quinchi travelled to different parts of Europe and carried the torch of Muslim civilisation wherever they went.

The Mozarabs (*Musta'rib*), who played an important part in the transmission and diffusion of Arab Science living next door to the Muslims, felt Arab influence more than others. The sweetness of the Arabic language appealed to them so much that they learnt Arabic enthusiastically and forgot their own Latin and Romance languages. They had the Bible translated into Arabic by John of Seville in 1049 A.D. An Arabic version of the "Cannons of the Council of Spain" was transcribed for the use of the Bishops and Clergy especially Bishop John Daniel, in the Moorish Kingdom[2]. The Mozarabs read Arabic poetry, stories and the works on Muslim philosophy and theology. Many Christian youths could express their views in Arabic more elegantly and correctly than in the Romance language. At huge expense they formed large libraries of Arabic books. Alvaro of Cordova bitterly complains against their leaning towards Muslim

1. Ameer Ali: Spirit of Islam, p. 287.
2. Casiri, I, p. 54.

learning. Cassar of Heisterbach speaks of Christian youths who went to study astronomy at Toledo. Hugh of St. Victor reproaches the Bishop of Seville for his keen interest in Muslim philosophy.

Arabic was commonly spoken in Leon, Castile, Navarre and other parts of Spain. From the third generation after the Muslim conquest of Spain, Spanish Muslims and Christians began to speak generally one and the same language called Romance. It was derived from low Latin but generally influenced by Arabic language. It was spoken by the Mozarabs and understood in courts of law and royal palaces. Its encouragement by the State is confirmed by the story of Giner and the Qadi.[1] Not only did the Romance language take over a large number of Arabic terms and words, either in their original form or in Latin garb, but also later Mudejares wrote the Spanish language in Arabic characters. Many Arabs understood Romance particularly in the frontier districts where they were called Latin Moors (Ladines).

1. Al-Khushani, Text, Translation and Introduction by Julian Riberia, Madrid, 1914.

CHAPTER 6

Influence on English Literature

Across the Pyrenees, literary, philosophic and military adventurers were perpetually passing, and thus the luxury, the taste and above all the chivalrous gallantry and elegant courtesies of Moorish society found their way from Granada into Provence. The French and English nobles imbibed the Arab admiration of the horse. Hunting and falconry, tilts and tournaments became their fashionable pastimes. And this reminds us of the Normans. Normandy, we know, is in France. The battle of Hastings is considered one of the decisive battles of the world. The effects of the Norman invasion on the English mind and fancy, which had been hitherto provincial and uncouth, were to infuse the lightness, grace and self-confidence of romance into the literature of the period. The genesis of modern English literature points to the north of France and the Trouveres, who were themselves influenced by the polished Moors of Spain. Just take the case of one of the great romances of the East, the Arabian Nights, and notice its influence. Many romantic writers of Europe have acknowledged their debt to even an imperfect translation of the tales. Balzac never turned to them in vain, when his prodigious imagination needed a spur. Thackery has told us in a charming passage how the "Nights" fascinated and inspired him. In the life of Charles Dickens we are told that the dormant imagination of the future novelist was roused to action by a perusal of the "Thousand and one Nights". Hawthorne's letters are filled with allusions to the stories whose influence can be traced

as clearly in many of the shorter stories. Stevenson, who knew the Burton version, writes in his Memoirs and Portraits, that the "Arabian Nights" was one of the books that helped to form his mind and style. There is no doubt that without the influence of "The Nights," Robinson Crusoe and Gulliver's Travels would not have seen the light of day.

Take the case of Shakespeare first. It is strange indeed that many trends of thought on pantheistic philosophy are to be found in Shakespeare's works. A passage in "The Tempest" will illustrate our meaning:

> "We are such stuff
> As dreams are made of,
> And our little life
> Is rounded with a sleep".

Shelley

Of all the English poets there is none so closely akin to the pantheistic type of mind as Shelley. In "Prometheus Unbound" Asia is the goddess of his worship. It may have been only an instinct that attracted one essentially of a deeply pantheistic spirit to the great home of Pantheism. "Life not the painted veil", he said "Which those who live call life, even though unreal shapes be pictured there". But in none of his works so much as in his Adonais does the Pantheism of Shelley appear in such dazzling radiance, embellished with all the charm of poetical colouring. The exquisite beauty of the following lines expressing the Oneness of Existence demands citation:

> "The One remains, the many change and pass,
> Heaven's light for ever shines, earth's shadow's fly.
>
> Life, like a dome of many coloured glass,
> Stains the white radiance of Eternity,
> Until death crushes it to fragments."

In tracing the scope of Eastern thought in England, one has also to mention the names of English mystics such as Law, George Herbert, Henry Vaughan and the Cambridge Platonists of modern poets. Arthur Symons' lines on "A Dancing Darvish" and Browning's "Paracelsus" and "Sordello", must have been read by many. Harris's poems are Sufistic in nature. In Phillip's beautiful poem "Parpessa" there are lines full of mysticism. Tennyson gives indications of being influenced by Oriental thought in "Akbar's Dream", and especially in "the Ancient Sage" he has given expression to some characteristic Oriental ideas in perhaps more fascinating form than any other poet. Mathew Arnold's mystic melancholy has a relationship with oriental temperament. Edwin Arnold, Ralph Griffiths, Max Muller and a host of other Orientalists have drawn their inspiration from the Oriental literature. In "Hero and Hero-worship" Carlyle designates Islam as a very superior faith and thinks that Mohammad is the hero of the prophets. In Gibbon's monumental work, Decline and Fall of the Roman Empire, reference to Islam's dynamic role in world civilisation bears an eloquent testimony to the remarkable influence Arabic literature, philosophy and thought exercised on these eminent scholars and thinkers.

CHAPTER 7

Scientific Progress

The Saracen Empire was dotted all over with colleges and universities, and in the heyday of Muslim power, Spain alone boasted of 70 libraries. Colleges were also established in Mongolia, Tartary, Persia, Mesopotamia, Syria, Egypt, North Africa, Morocco and Fez. Learning received great patronage at this time. The ancient sciences were gradually extended and new ones brought into existence.

Astronomy and Mathematics

There is no doubt that a galaxy of scientific and learned men flourished during the heyday of Muslim civilisation and they have in some way or other, left their indelible mark on the history of human progress. The arrival of an Indian mathematician and astronomer, Manka, at the Court of Abu Ja'afar Al-Mansur in 770 A.D. with a copy of *Siddhanta* (a Sanskrit treatise on astronomy) induced the great patron of learning to get the work translated into Arabic. Mohammad ibn Ibrahim al-Fazari and Yaqub ibn Tariq performed the task successfully.[1] This was a great incentive and produced a band of astronomers who ransacked all the available knowledge of astronomy, worked with industry and made original contributions to this science upto the 14th century.

Al-Fazari was the first Muslim to construct an astrolabe. He wrote on the use of the armillary sphere and prepared tables according to the years of the Arabs.[2]

1. Al-Qifti, pp. 366-368.
2. Legacy of Islam, p. 380.

Among his famous treatises are *Kitab-al-Miqyas*, *Kitab-al-Zij*, *Kitab-al-'Amal bil Asturlab* and, *Kitab-al-Qasidah fi 'Ulum al-Nujum*.[1] The excellent book of tables was edited and published by Masalama al-Madijrite. In the book there are trigonometrical tables in which the word *gaib* is always used for "Sine".

Ameer Ali sums up the subject thus: Mashallah, a Jew, and Ahmad ibn Mohammad Al-Nehavendi, the most ancient of the Arab astronomers, lived in the reign of Al-Mansur. The former, who has been called the Phoenix of his time by Abul Faraj, wrote several valuable treatises on the astrolabe and the armillary sphere, and the nature and movements of celestial bodies—works which still evoke the admiration of scientists. He is credited to have fixed the date and hour for the foundation of Baghdad by the order of Al-Mansur. In numerous works he covered the whole field of astrology and also the making and uses of astronomical instruments. Many of his works have been translated into Latin by Johannes Hispalensis and also printed later on.[2]

Ahmad al-Nehavendi wrote from his own observations an astronomical table, *al-Mustamal*, which formed a decisive advance upon the notions of both the Greeks and the Hindus. Under Al-Mamun, the Almagest of Ptolemy was re-translated, and the Verified Tables prepared by the famous astronomers like Sind ibn Ali Yahya ibn Abi-Mansur and Khalid ibn Abdul Malik. Their observations connected with the equinoxes, the eclipses, the apparitions of the Comet and other celestial phenomena were valuable in the extreme, and added greatly to human knowledge.[3]

Before the middle of the ninth century, al-Mamun erected observatories at Baghdad and outside Damascus for scientific observations and for determining the

1. Al-Fihrist, p. 273, Al-Qifti, pp. 91-92.
2. Al-Qifti, pp. 424-425 and Spirit of Islam, p. 373.
3. Spirit of Islam, p. 374.

size of the earth and its circumference on the assumption that the earth was round. From these observations the tables called "Tested Tables" or Tables of Al-Mamun, were prepared according to the method of the Sindhind. Ahmad al-Farghani was the most distinguished astronomer of his age and well-known to the medieval West. His book, *Harakat-al Samawiyah wa Jawami Ilm-al-Nujum* (Book on Celestial Motions and the complete Science of the Stars), a work much-esteemed, was translated into Latin by Gerard of Cremona and Johannes de Luna Hispalensis. It exercised a remarkable influence on European astronomy. He accepted Ptolemy's theory and value of the precession but was of the view that it affected not only the stars but also the planets. He determined the diameter of the earth to be 6,500 miles, and found the greatest distances and also the diameters of the planets.

During the Renaissance, Regiomontanus studied it and the great Melanchton published an edition based on the work of Regiomontanus at Nuremberg in 1537.[1] His Arabic text still exists in Oxford, Paris, Cairo and the library of Princeton University.

Al-Khwarizmi made a new translation of *Siddhanta*, with his own comments and observations. He composed two books on astronomy: *Kitab al-'Amal bi'l Asturlab*, on the Manner of Using the Astrolabe) and *Kitab al-Amal al-Asturlab*, (on the Art of Making the Astrolabe). Neither has survived in Arabic or Latin.[2]

Al-Kindi wrote no less than 265 works on different subjects including mathematics and astrology. According to Sedillot, "his works are full of curious and interesting facts".

Abu Ma'shar

The Muslims learned astronomy from the writings of Greek masters and also assimilated all the available

1. Legacy of Islam, p. 381, Al-Qifti, p. 124 and G. Sarton, p. 567.
2. Al-Fihrist, p. 274.

knowledge from Persia, Egypt, Syria, Iraq and India, and built up their own edifice of astronomical and mathematical science by their indefatigable endeavour, keen observation, incessant practical research and inquiry. The results of these experimental researches have been scientifically incorporated by Abu Ma'shar (known to the West as Albumasar). He was a contemporary of Al-Kindi and at the age of forty he devoted his attention to the study of astronomy and astrology. He passed the major portion of his life at Baghdad and died at Wasit in 886 A.D. He made the celestial phenomena his special study; and his *Zij-abi-Ma'sher* or the Table of Abu Ma'shar has always remained one of the chief sources of astronomical knowledge. Among his famous works are *Kitabul Mudkhal al-Kabir*, *Kitabul Q-iranat*, *Kitab al-Uloof* and *Mawalidul Rijal Wal Nisa'*.[1]

According to Baron Carra de Vaux, "Abu Ma'shar was an astronomer and astrologer of great renown. Four of his works, including *De Conjunctionibus et. annorum revolutionibus*, were translated into Latin by Johannes Hispalensis and Adelard of Bath.[2]

Banu Shakir

The outstanding researches of the three sons of Musa ibn Shakir, known as Banu Shakir (Mohammad, Ahmad and Hasan) in respect of the evaluation of the mean movement of the sun and other astral bodies, are almost as exact as the latest discoveries of Europe. They erected their own observatories for research and observation, and ascertained with remarkable precision, the obliquity for the ecliptic, and marked for the first time the variations in the lunar altitudes. They also determined with wonderful accuracy the precession of equinoxes, and the movements of the solar apogee (which were unknown to the Greeks). They calculated the size of the earth from the measurement

1. Al-Fihrist, p. 274, Ibn Khallikan, Vol. I, pp. 325-326.
2. Legacy of Islam, p. 387.

of a degree on the shore of Red Sea at a time when Christian Europe was asserting the flatness of the globe. Abul Hasan invented the telescope, a tube to the extremities of which were attached diopters. These were improved and used afterwards in the observatories of Maragha and Cairo.[1]

"We owe a number of works to these three brothers (Banu Shakir), one of which, on the measurement of plane and spherical surfaces, was translated into Latin by Gerard of Cremona under the title *Liber Trium Fratrum*. They wrote a treatise on mechanics which is preserved in the Vatican".

According to Ibn Khallikan, Mohammad ibn Musa ibn Shakir was one of the three brothers after whom the art of engineering was called the Contrivances of the sons of Musa (Hilal bani Musa), he and his brothers, Ahmad and Al-Has-an, being celebrated for their talents in that line. Animated with the noble ambition of learning the sciences of the ancients and acquiring their books, they laboured to attain this objective and sent persons to bring them such books from the country of the Greeks. By offering ample rewards they drew translators from distant countries, and thus made known the marvels of the science to all the Arabic speaking world. Geometry, engineering, the movements of heavenly bodies (*Kitab Harakat an-Nujum*), music, and the science of the stars were the principal subjects to which they turned their attention, but these were only a small number of their acquirements. They composed on engineering an original and singular work, filled with every sort of curious information. Their other famous works are, *Kitab-al-Shakl* and *Kitab-al-Khurutat*.[2]

The Arabs were very skilful in the construction of Clepsydras, water-clocks with automata; it will be

1. Al-Qifti, pp. 409-410; Al-Fihrist, p. 270.
2. Ibn Khallikan, Vol. III, pp. 315-317.

remembered that Harun al-Rashid sent one as a present to Charlemagne.[1]

The emergence of Buwayhids to power was not only significant but also marked a turning-point in the scientific and cultural evolution of the Muslims. Sultan Sharf-al-Dawlah built an observatory in his palace at Baghdad in 982 A.D. and there flourished a host of astronomers, physicists and mathematicians, of whom Abdur Rahman al-Sufi, Abul Wafa, Rustam al-Kuhi and Ahmad al-Saghani need special mention.

Al-Sufi

Al-Sufi, among practical astronomers, is held in very high esteem. He was born in 903 A.D. and died in 986 A.D. His illustrated treatise *Kitab al-Kawakib al-Thabit al-Musawwar* (available in original Arabic as well as in the French translation of Schjellerup) contains a catalogue of stars based on his own observations, giving their magnitudes and coordinates. It is the first star atlas to take cognizance of the nebula in Andromeda and is of great importance even at present, as it has revealed the changes undergone by a number of prominent stars in their magnitudes, in the course of ten centuries, and may throw some light on their proper motions also.[2]

Abul Wafa

Abul Wafa was born in 940 A.D. at Buzjan in Khorasan and died in 998 A.D. He introduced the use of the secant and the tangent in trigonometry and astronomical observations. His chief works are *Al-Kitabul Kamil* and *Kitab al-Hindisah*.[3]

Ibn Khallikan thinks that Abul Wafa was a celebrated calculator and one of the most distinguished masters in the science of geometry. He deduced from geometry certain corollaries which had till then remained undiscovered.

1. Legacy of Islam, pp. 386-387.
2. Al-Fihrist, p. 284; Al-Qifti, pp. 314-315.
3. Al-Fihrist, p. 283; Al-Qifti, p. 388.

Ibn Yunus highly extolled his works, taking them as guides in most of his investigations and citing the author's words as a conclusive authority. Abul Wafa composed a good and useful treatise on the manner of finding the value of chords of arcs (*Fi Istikhraj al-Autar*. He also wrote *Manazil*, a good arithmetical treatise and *Mudkil*, an introduction to arithmetic.[1]

He gave a new method of constructing sine tables, the value of sine 30′ being correct to the 8th place of decimal.[1] A number of European mathematicians for example Delambre in *Histoire de L'astronomie av Moyen* Age and H. Suter in the Encylopaedia of Islam, have discussed isolated problems handled by Abul Wafa but no extensive text of his work has yet been published.[2]

Carra de Vaux has evaluated his contributions saying "Abul Wafa's services to trigonometry; are indisputable." With him trigonometry becomes still more explicit and acquires the formula for the addition of the angles:

$$\text{Sin}(a+b)=\frac{\text{Sin a Cos b}+\text{Sin b Cos a}}{R}$$

The formula, discovered at this time, did not, however, become known to the Latin world and Copernicus seems to have been unaware of it. Rhaeticus, the pupil and editor of Copernicus, rediscovered it very laboriously in his *Opus Platinum de Triangulis*, after having given another formula much more complicated than Abul Wafa's. This is not the end of the services rendered by Abul Wafa to science. A geometer of great ingenuity, he dealt with a number of problems and studied the quadrature of the parabola and the volume of the paraboloid; in algebra, he translated and made an exhaustive commentary on Diophantus, but these writings are lost.[3]

1. Ibn Khallikan, Vol. III, pp. 320-321.
2. George Sarton, Vol. I, p. 667.
3. Legacy of Islam, pp. 389-390 and Encyclopaedia Britannica, Vol. I, p. 54.

Al-Kuhi

Rustam Al-Kuhi studied the movements of the planets. His discoveries concerning the summer solstice and the autumnal equinox were extremely important.

"Al-Kuhi puts the problem in this form: to construct a segment of a sphere equal in volume to a segment of a given sphere and in surface to another segment of the given sphere. He solves it ingeniously with the help of two auxiliary cones and two conics: an equilateral hyperbola and a parabola, and he then discusses the limits. His chief works are, *Kitab al-Sana'i al-Asturlab*, *Kitab al-Istikhraj Zala' al-Musabba*, and *Kitab al-Markaz al-Kurra*.[1]

Al-Saghani

Ahmad al-Saghani probably made the astrolabes and other instruments used by himself and other astronomers devoted to the observational work in Sharf-al-Dawlah's observatory.

Ibn Yunus

Astronomical studies were pursued with great interest in Egypt during the Fatimide Caliphs, Aziz billah and Hakim bi Amr-illah, who erected an observatory at Cairo and attracted a number of astronomers and scientists. The most distinguished and prominent figure was Ahmad ibn Yunus, the son of a famous historian and traditionalist. Ibn Yunus conducted research and wrote *al-Zij-ul Kabir al-Hakimi* in 990 A.D. It is also called *Zij Ibn Yunus*. In this treatise he discusses the subject in detail and indicates the application of rules which are given there. The correctness of his findings testifies the great care with which it was drawn up. His work is so highly esteemed for correctness, that like the *Zij* of Yahya Ibn Ali Mansur, it is recognised by the people of Egypt as the standard authority in calculating the position of the heavenly bodies.[2]

1. Legacy of Islam, p. 394; Al-Fihrist, p. 283, Al-Qifti, pp. 455-457.
2. Al-Qifti, p. 319 and Ibn Khallikan, Vol. II, pp. 365-367.

This great work soon displaced the work of Claudius Ptolemy. It was reproduced for the Persians by Omar Khayyam (1079); among the Greeks, in the Syntax of Chrysococca; for the Mongols by Nasir-uddin Tusi in the *Zij-il-Khani*; and among the Chinese in the astronomy of Co-Cheou—King in 1280; and "thus what is attributed to the ancient civilisation of China is only a borrowed light from the Muslims[1].

Ibn Yunus was also the inventor of the pendulum and the measurement of time by its oscillations. After his death in 1009, his discoveries were continued by Ibn un Nabdi who lived in Cairo in 1040 A.D.

A wave of enthusiasm stirred the minds of the people in Shiraz, Nishapur and Samarkand, where observatories were erected to conduct scientific observations, develop astronomical science and accelerate the progress of human knowledge and understanding.

Thabit ibn Qurrah

Thabit ibn Qurrah was one of the greatest figures among the promoters of Arab learning in the ninth century. He was born in 836 A.D. at Harran and took keen interest in the study of mathematics, physics and philosophy. He met Musa ibn Shakir, who recognising his mathematical talent and linguistic ability, took him to Baghdad and recommended him to Caliph Mu'taḍid, who appointed him as one of his Court astronomers. There he spent the greater part of his life in translating Greek mathematical works and philosophical studies. He died in February, 901 A.D.[2]

Thabit wrote twenty treatises or memoirs on astronomy and geometry, elucidating different branches of science including numerous passages from ancient works, inventing new propositions, annotating and facilitating study. His work on the shadows of the gnomon, *i.e.* on the sundial, is the earliest that we know on this subject. His treatise on the balance, *Liber Carastonis*

1. Spirit of Islam, Ameer Ali, p. 377; Al-Qifti, p. 319.
2. Ibn Khallikan, Vol. I, pp. 288—291; Al-Fihrist, p. 302; Ibn Abi Usaybiah, Vol. I, pp. 215—220, Al-Qifti, pp. 174—184.

Sive de Statera, was translated into Latin by Gerard of Cremona. He also recorded his observations in a book on the altitude of the sun and the length of the solar year.

After Thabit his sons Ibrahim and Sinan, his grandsons, Thabit and Ibrahim, and great-grandson, Abul Faraj, continued the work of translation and compilation, enriching mathematics and astronomy with their original discoveries and observations. Sinan was the first to embrace Islam and died in 943. His son, Ibrahim was born in 903 and died at the early age of 37 or 38, but left an abiding impress on the canvas of scientific history through his quadrature of the parabola, the simplest ever made before the introduction of integral calculus.[1]

Abul Has-an Thabit ibn Sinan was a very learned and skilful physician and taught the works of Hippocrates and Galen. He showed great perception in discovering the sense of obscure passages and trod in the footsteps of his grandfather, cultivating like him, medicine, philosophy, geometry and the exact sciences of the ancients (which were comprehended under the term of *Quadrivium* by schoolmen of the middle ages, and are according to Haji Khalifas geometry, astronomy, arithmetic and music).[2]

Writing about the great advance made by the Muslims in the domain of mathematics, Joseph Hell comments: "Taking over the elements of mathematics from Euclid, the decimal system from the Indians in the ninth century, they soon made substantial progress. The adoption of the sign 'Zero' (Arabic, *Sifr*) was a step of the highest importance, leading up to the so-called arithmetic of positions. With the help of the Arab system of numbers, elementary methods of calculation were perfected; the doctrines of the properties of, and the relations between, the equal and the unequal and

1. Al-Qifti, pp. 93, 169-171 and 274-280; Ibn Abi Usaybiah, pp. 220—227 and George Sarton, Vol. I, p. 624.
2. Ibn Khallikan, Vol. I, pp. 288—291.

prime numbers, square and cubes, was elaborated; algebra was enriched by the solution of the third and fourth degrees, with the help of geometry and so on. About the year 820 A.D. the mathematician Al-Khwarizmi wrote a text book of algebra in examples, and this elementary treatise—translated into Latin—was used by the Western scholars down to the sixteenth century."[1]

Al-Khwarizmi

The dates of birth and death of Mohammad ibn Musa al-Khwarizmi (780-850 A.D.) are uncertain, but according to H. Suter he died between 835-844, and C.A. Nallino thinks it is after 846-47. He flourished in the Golden Age of Al-Mamun, worked as his astronomer and took part in the measuring of the degree. He was a voracious reader and used to devote his time to study and research in the royal library. He took great interest in mathematics, geography, astronomy and history. He wrote *Kitab al-Tarikh* and his writings reveal that his personality was imbued with scientific genius. Al-Nadim in his Fihrist has given a list of Al-Khwarizmi's writings which show profundity of his mind.[2]

His most important mathematical work is on Algebra, *Hisab al-Jabr Wa'l Muqabla*.[3] This book not only gave the name to this significant branch of mathematics to the European world but also contained, in addition to the usual analytical solutions of linear and quadratic equations, graphical solutions of typical quadratic equations. It was revised by Abu Kamil Shuja Ibn Aslam in the first half of the tenth century.[4] J. Ruska terms this work as "Process of Calculation for Integration and Equation". The book contains very

1. Arab Civilisation, p. 97.
2. Al-Fihrist, p. 274, Al-Qifti, pp. 385-386.
3. The Algebra was edited and translated into English by F. Rosen (1831).
4. Al-Fihrist, p. 274, Al-Qifti, pp. 385-386; George Sarton, Vol. I, p. 563.

varied matter: a) processes of integration and equation, the simplest forms of equations; b) Surveying and mensuration, c) testamentary regulations for division of inheritances. The book was translated into Latin by Gerard of Cremona, Robert of Chester and Adelard Bath.

Al-Khwarizmi's book was used until the 16th century as the principal mathematical text book of European universities, and served to introduce into Europe the science of Algebra, and with it the name. His work was also responsible for the introduction of the Arabic numerals, called "Algorisms" after him, into the West. Prof. S.C. Kleene of the University of Wisconsin, in his Voice of America Forum Lectures on "Computability" has correctly remarked: "The class of questions: Is this list of sentences a proof ? is a modern example of a class of questions, each question of which class can be answered without ingenuity by applying given rules. The rules, or procedure, for answering any question of such a class have been called an algorithm, after the corrupted name of the ninth century Arabian mathematician, Al-Khwarizmi".[1]

Carra De Vaux commenting on the book says: "The Algebra of Al-Khwarizmi is lucid and well-arranged. After dealing with equations of the second degree, the author discusses algebraic multiplication and division; he then treats of problems relating to the measurement of surfaces and deals with others relating to the division of estates or various legal questions; these latter, which are generally equations of the first degree, although very complicated to look at, are all propounded in the form of numerical examples. The method of approaching the equation of the second degree is important. The author, following Diophantus, distinguishes six cases, one of which, however, is given only for the sake of completeness, for it is identical with the simplest case of the first degree,

1. Philosophy of Science, p. 43, Voice of America Lectures.

b x=C. The six cases are: squares equal to roots, $ax^2=bx$; squares equal to numbers, a $x^2=C$; roots equal to numbers, b x=C; squares and roots equal to numbers, $ax^2+bx^2=C$; squares and numbers equal to roots, $ax^2+C=bx$; roots and numbers equal to squares, $bx+C=ax^2$.....Al-Khwarizmi, having thus enumerated the six possible cases, gives the rules for their solution and in letters of the alphabet, he proves the rules."[1]

Al-Khwarizmi's writings have influenced Abu Kamil, Al-Karkhi, Omar Khayyam and Leonardo of Pisa.

An arithmetical work of Al-Khwarizmi only survives in a Latin translation, which, according to J. Ruska, is *Kitab-al-Jam'Wal Tafriq*. (Book of Addition and Substraction). His treatises on astronomy and arithmatic are also known only from their Latin translations.

Al-Battani

Two of the oldest Muslim astronomers Al-Farghani and Al-Battani were the preceptors of Europe and under the names Alfraganus and Albategnius enjoyed high reputation.

Abu 'Abdullah Mohammad Ibn Jabir al-Battani, undoubtedly the greatest Arab astronomer of his time, was born before 858 A.D. His family formerly professed the Sabian religion but he came to the fold of Islam.[2] He spent almost his whole life at Al-Raqqa, on the left bank of the Euphrates, where several families from Harran had taken up their abode. From 877 to 918 he devoted himself to astronomical observations and made some original contribution in this field. He dedicated his life to the pursuit of knowledge and learning till his death in 929 A.D. at a place called Qasr al-Hadr.

1. Legacy of Islam, pp. 381-82.
2. Encyclopaedia of Islam, new edition, Vol. I, p. 1104; Ibn Khallikan, Vol. III, pp. 317—320.

Some of his works of outstanding merit are:— *Kitab Ma'rifat Matali al-Buruj fi Mabaine Arab al-Falak*, *Risala fi Tahqiq Miqdar-il-Ittisalat*, *Sharh l-Maqalat al-Arab le Batlamyus and Al-Zij* (Astronomical treatise and tables), which is his principal work and the only one that has survived.[1] It contains the results of his observations and has exercised considerable influence, not only on Arab astronomy but also on the development of astronomy and spherical trigonometry in Europe during the Middle Ages and the beginning of the Renaissance. In his table, he marked the positions occupied by the fixed stars in the year 911-912 A.D. He was the paragon of the age in the art which he cultivated, and his operations furnish a proof of his great talents and extensive information. It was translated into Latin by Robertus Retinensis and Plato Tiburtinus in the first half of the 12th century and published at Nuremberg in 1537. C.A. Nallino and J.M. Millas have also edited and translated his work.

Al-Battani determined with great accuracy the obliquity of the ecliptic, the length of the tropic year and of the seasons and the true and mean orbit of the sun. He definitely exploded the Ptolemaic dogma of the immobility of the solar apogee by demonstrating that it is subject to the precession of the equinoxes and that in consequence the equation of time is subject to a slow secular variation. He proved, contrary to Ptolemy, the variation of the apparent angular diameter of the sun and the possibility of annular eclipses, rectified several orbits of the moon and the planets, propounded a new and very ingenious theory to determine the conditions of visibility of the new moon and emended the Ptolemaic value of the precession of the equinoxes. His excellent observations of lunar and solar eclipses were used by Dunthome in 1749 to determine the secular acceleration of motion of the moon. Finally, he gave very neat solutions by means

1. Al-Fihrist, pp. 279-280.

of orthographic projection for some problems of spherical trigonometry; solutions which were known to and in part imitated by the celebrated Regiomontanus (1436-1476).

He discovered the motion of the sun's apogee and assigned to annual precession the improved value of 54.5″ and to the inclination of the ecliptic that of 23°35′ ; and he showed that annular eclipses of the sun were possible. It was from the study of his dissertion on the apparent motion of the fixed stars that Hevilius discovered the secular variation of the moon.

Joseph Hell has rightly remarked: "In the main of trigonometry the theory of sine, cosine and tangent is an heirloom of the Arabs. The brilliant epochs of Peurbach, of Regiomontanus, of Copernicus, cannot be recalled without reminding us of the fundamental and prepatory labours of the Arab Mathematician".[1]

During the 11th and 12th centuries, the Muslims of Spain took a keen interest in astronomical research and erected observatories at Cordova, Toledo and Seville. The first observatory in Europe was built by the Arabs. The Giralda or tower of Seville was built under the supervision of the great mathematician Jabir ibn Aflah in 1190 A.D. for the observation of the heavens. His book *Kitab al-Haiyat* is famous.

Another eminent astronomer of Cordova was Abul Qasim Maslamah al-Majriti (1007) who revised and edited Al-Khwarizmi's *Zij*.

Al-Zarqali

Ibrahim ibn Yahya al-Zarqali of Toledo, known to the Latin world as Arzachel (1029-1087 A.D), is reputed as an instrument-maker. His astronomical 'Tables of Toledo' were well-known and used. His determination of the obliquity of the Ecliptic is correct to within one minute of arc, and the length of the Mediterranean Sea 42°, much nearer the truth than

1. Arab Civilisation, p. 97.

Ptolemy's exaggerated 62°. He invented an astrolabe, a Safiha, and wrote a treatise, out of which a whole literature developed.[1] It was translated into Latin, and Regiomontanus in the 15th century published a collection of problems on the 'noble instrument of *Safiha*. Copernicus quotes Al-Zarqali along with Al-Battani in his book *De Revolutioni bus Orbium Coelestium*.

Al-Bitruji

The other renowned astronomer, Nuruddin Al-Bitruji (Alpetragius, died in 1204 A.D.) who was a pupil of the distinguished philosopher and physician Ibn Tufail, made some original contributions on the movements of the planets and wrote a book which was translated into Hebrew by Moses ben Tibbon. It was also rendered into Latin by Kalonymos ben David.

Abu Bakr Mohammad Ibn Bajjah

Abu Bakr Mohammed Ibn Bajjah ranks among the most celebrated thinkers of Spain. He was an outstanding physician, mathematician and astronomer and was born at Saragossa towards the end of the 11th century. He was the first outstanding Spanish representative of the Arabic Aristotalion—Neoplatonic philosophical tradition. He went to Africa and was offered a high position in the Court of Almoravids. He died at Fez in 1138 A.D. He prepared the ground for Ibn Tufail and Ibn Rushd who used his exegesis of Aristotle to a large extent. There are editions of Ibn Bajjah's work on botany, of his treatise on the union of the "active intellect" with the human soul and his letters of farewell by M. Asin Palacios, a Spanish translation, in Al-Andalus, Voll. V, VII and VIII (1940-43) and an edition of his Rule of the Solitary by D.M. Dunlop with an English translation, in the Journal of the Royal Asiatic Society (1945).[2]

1. Al-Qifti, pp. 92-93.
2. Encyclopaedia Britannica, Vols. I & II; Ibn Abi Usaybiah, Vol. II, pp. 62-64; Ibn Khallikan, Vol. III, pp. 130—133.

Al-Biruni

With the advent of the 11th century, a new political power emerged on the map of Central Asia under Sultan Mahmud of Ghazna whose empire extended over Trans-Oxiana, Afghanistan and Persia. His magnificent court and the most splendid university became the centres of scientific and intellectual gravity and attracted renowned scholars. Among the illustrious exponents of the physical and mathematical sciences Abu Rayhan Mohammad Al-Biruni's (973-1048) name stands out prominent. He is known as "the Master" (*al-Ustad*). He is considered the most profound and original savant and mathematician that Islam produced in the realm of natural sciences. In a most ingenious manner he determined the magnitude of the earth's circumference. He brought out in 1030 A.D. an account of the whole science of astronomy called *al-Qanun al-Mas'udi fi al-Hayat wal-Najum*, the book entitled after his patron Sultan Mas'ud. He has discussed scientifically the then controversial theory of earth's rotation on its axis and made accurate determination of latitudes and longitudes in the book.[1]

Al-Biruni was endowed with an encyclopaedic mind and possessed keen observation. He travelled extensively in India and studied the language, philosophy, science and literature of the Hindus and compiled his observations in his book, *Tarikh al-Hind*, which has been rendered into English by Dr. Edward Sachau. Al-Biruni also wrote an abstract of geometry, arithmetic, astronomy and astrology, *Kitab al-Tafhim Li Awa'il-i-Sina'at al-Tanjim*. An English translation facing the text was published by Ramsay Wright, London, in 1939. His description of various natural phenomena like Zodiacal Light, his correct explanation that the rise of water in springs is due to hydrostatic pressure and his suggestion that the Indus Valley was once an arm of the sea, reveal his wonderful powers of accurate observations and investigations.

The total number of Al-Biruni's works is considerable, about 180. Four of his mathematical and astronomical treatises have been published in Hyderabad (Deccan), India, in 1948, in a single volume entitled *Rasail al-Biruni*. There is also a translation and commentary on *Al-Biruni* by H. Suter in *Bibliotheca Mathematic*, Leipzig, 1910-11.[1]

Omar Khayyam

Mahmud of Ghazna (998—1030) and his successors bequeathed a glorious legacy of scientific and intellectual progress, but their political ascendancy gradually waned and the Seljuks rose to power and asserted their hegemony. Tughril Beg, Alp Arslan, Malik Shah and Sanjar distinguished themselves for patronising learning and science and were gifted with remarkable intellect and wisdom. Jalaluddin Malik Shah and his Prime Minister, Khawja Hasan Nizam-ul-Mulk, infused a new spirit of inquiry and research and drew a large number of astronomers, poets, scholars and historians. They erected an observatory at Nishapur where Omar Khayyam and Abdur Rahman al-Khazini supervised the observations.[2]

Khayyam was a star of first magnitude among the contemporary mathematicians, scientists and poets, and died in 1123 A.D. He was invited by Malik Shah to collaborate in the reform of the Persian Calendar which he performed successfully. This preceded the Gregorian by 600 years and is said to be even more exact.[3]

The manuscript of Khayyam's principal work on algebra exists in Leyden, Paris and London. His introduction to his researches on Euclid's axioms (*Musadarat*) has been translated by Jacob and Wiedemann. George Sarton calls Khayyam "one of the greatest mathematicians of medieval times". His

1. Ibn Abi Usaybiah, Vol. 11, pp. 20-21.
2. Ibn Khallikan, Vol. III, pp. 230-234.
3. Sedillot and Al-Qifti, p. 334.

algebra contains geometric and algebraic solutions of equations of the second degree; an admirable classification of equations, including the cubic; a systematic attempt to solve them all, and partial geometric solutions of most of them. Both analytical and geometrical solutions were explained for the second degree and attempted and partially solved for the third degree. Khayyam recognised thirteen diffeernt forms of cubic equations and arranged them in the order of their complexity depending on the number of terms involved. He also worked on the determination of specific gravities.[1]

Bertrand Russell justly remarks, "Omar Khayyam, the only man known to me who was both a poet and a mathematician, reformed the Calendar in 1079 A.D.[2]

Khayyam's Algebra marks a stage in the advance of this branch of mathematics. Following on the excellent edition which he published in 1851, the learned French editor Woepcke collected several other problems which were popular with Arab mathematicians and also presuppose a knowledge of conics, like the problem of the two proportional means, the trisection of an angle, the construction of regular polygons and especially of the enneagon. Several solutions of the problem of the trisection of an angle were known to the Arabs.[3]

The other eminent astronomer Al-Khazini established his reputation with his comprehensive work on the balance, *Mizan-al-Hikamah*, published with annotations and notes in Hyderabad (Deccan), India.

With the onslaught of Chengiz Khan on Samarkand, Bokhara, Balkh and Persia, and the successive invasions of Halaku in 1258, the Caliphate of Baghdad was completely shattered and disintegrated into a

1. Omar as Mathematicians, W.E. Story, Boston; Omar Khayyam, Syed Sulaiman Nadvi, 1933, Azamgarh, India.
2. History of Wesern Philosophy, p. 416.
3. Legacy of Islam,t p. 393.

series of autonomous regional sovereignties sapping the very foundations of the central authority. Palaces, public buildings, precious libraries and treasure houses were destroyed and burned. The fall of Baghdad gave a death-blow to the magnificent culture and civilisation built up by the Muslims.

Al-Tusi

But fortunately there arose on the horizon of Islam the Mamluk Sultans of Egypt who by 1280 reasserted their hegemony and rehabilitated the lost culture and scientific activity. These Mongols later came to the fold of Islam and took a keen interest in reawakening the spirit of learning. Halaku appointed Nasiruddin Tusi as his adviser and directed him to build an observatory in 1256 at Maragha and later at Samarkand to conduct observation. Tusi, born in 1201, joined Halaku's services and became Vizier of *Waqf* (trust) estates. He retained his dominating position under Abaka also, without interruption.

His most famous and original work is *Kitab-al-Shakl-al-Qatta* (known to medieval Latin Europe as *Figure Cata*), a work on the principles of transversal, from which he deduces relations of fundamental importance in spherical trigonometry.[1] He also wrote a book on arithmetic, *Mukhtasar bi Jami al-Hisab*.

In the field of astronomy, Tusi achieved great fame with his keen observations and outstanding researches. The Maragha observatory was fully equipped with a number of excellent and newly designed instruments for conducting observations.

"The instruments at Maragha were much admired. The Arab astronomers devoted great attention to the perfecting of instruments. The most important was the armillary sphere, which was known to the ancients and represented in a general way the celestial sphere; it consisted of three rings corresponding to the meridian, the ecliptic, and the colure of the solstices, and of two

1. George Sarton, Vol. II, Part II, pp. 1001-7.

rings of observation. The Arabs completed and perfected the sphere of Ptolemy and of the Alexandrians. They added to it two rings giving the co-ordinates of the stars in respect to the horizon, then a ring for the observation of the altitudes. They endeavoured to make their instruments as large as possible in order to minimize error; they then began to make special instruments, each being devoted to a special class of observations. In the observatory at Maragha there were instruments made of rings for special purposes: ecliptical, solisticial and equatorial armillaries. The ecliptical, which was very much used, had five rings, the largest of which was some twelve feet across. It was graduated in degrees and minutes. When Alfonso of Castille wanted to construct an armillary sphere, which would be the finest and best that had yet been made, it was to the Arabs that he turned for information. At the Renaissance, Regiomontanus, in order to reconstruct the ecliptical of Ptolemy, used Arabic books and it was from then that he became acquainted with the alidade, the name of which is Arabic."[1]

The Maragha observatory comprised a team of highly qualified and talented staff of observers. Tusi was already sixty when the building was begun, but he was spared another twelve years to finish completely his task of calculating new planetary tables based on comprehensive observations. The results of his calculations have been recorded in *Zij-i-Ilkhani* (The Ilkhanian Tables). The first *Maqala* (treatise) deals with eras, the second with the movements of the planets and the third and fourth are devoted to astrological observations. His other work of significance is the *Kitab-al-Tazkira al-Nasirya*, a survey of the whole field of astronomy, on which a number of later scholars wrote commentaries. H. Suter has given the best account of Tusi. Nurullah Shustry in *Naqd-al-Rijal* and Mohammad in *Roazah-al-Jannat* have evaluated justly his astronomical achievements.

1. Legacy of Islam, pp. 395-396.

Tusi received his main training under the renowned astronomer Kamaluddin ibn Yunus, and before taking his position at Maragha had probably written his *Tazkirah fi Ilmal Hai'a* (compendium on the Science of Astronomy), a very condensed book on astronomy. His criticism of Ptolemy's *Almagest* regarding the theory of planetary motion paved the way for the introduction of Copernican system.

Shirazi

Nasiruddin Tusi's most brilliant pupil, Qutbuddin Shirazi (1236—1311) wrote *Nihayat-al-Idrak fi Dirayat-al-Aflak*, which is largely a development of the *Tazkirah* in astronomical topics, but also contains valuable discussions on geometrical optics like the nature of vision and the formation of the rainbow. The primary bow is explained as due to two refractions and one internal reflection, and the secondary to two refractions and two internal reflections of solar rays in minute spherical dross of water suspended in the air—essentially the same as that given by Descartes in the sixteenth century. Of course, the colours of the rainbow had to wait till Newton's experiments on the dispersion of light for their correct interpretation."[1]

Ulugh Beg

Timur's (Tamerlane's) grandson Sultan Ulugh Beg (1393—1440), who was himself an erudite scholar, took great interest in the science of astronomy and published a catalogue of stars comparing his own observations of their magnitude etc. with those of Ptolemy and al-Sufi, alongwith planetary tables. He erected a large observatory at Samarkand and gathered round him a team of scholars and scientists to make researches. The prominent astronomers of this period were Jamshed al-Kashi and Ali Ibn Mohammed al-Qashji.

Al-Kashi (died 1436 A.D.) was the first director of this observatory and a great mathematician and

1. Muslims Contribution to Science and Culture, M. Abdur Rahman Khan, pp. 57-58.

rings of observation. The Arabs completed and perfected the sphere of Ptolemy and of the Alexandrians. They added to it two rings giving the co-ordinates of the stars in respect to the horizon, then a ring for the observation of the altitudes. They endeavoured to make their instruments as large as possible in order to minimize error; they then began to make special instruments, each being devoted to a special class of observations. In the observatory at Maragha there were instruments made of rings for special purposes: ecliptical, solisticial and equatorial armillaries. The ecliptical, which was very much used, had five rings, the largest of which was some twelve feet across. It was graduated in degrees and minutes. When Alfonso of Castille wanted to construct an armillary sphere, which would be the finest and best that had yet been made, it was to the Arabs that he turned for information. At the Renaissance, Regiomontanus, in order to reconstruct the ecliptical of Ptolemy, used Arabic books and it was from then that he became acquainted with the alidade, the name of which is Arabic."[1]

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Nasiruddin Tusi's most brilliant pupil, Qutbuddin Shirazi (1236—1311) wrote *Nihayat-al-Idrak fi Dirayat-al-Aflak*, which is largely a development of the *Tazkirah* in astronomical topics, but also contains valuable discussions on geometrical optics like the nature of vision and the formation of the rainbow. The primary bow is explained as due to two refractions and one internal reflection, and the secondary to two refractions and two internal reflections of solar rays in minute spherical dross of water suspended in the air—essentially the same as that given by Descartes in the sixteenth century. Of course, the colours of the rainbow had to wait till Newton's experiments on the dispersion of light for their correct interpretation."[1]

Ulugh Beg

Timur's (Tamerlane's) grandson Sultan Ulugh Beg (1393—1440), who was himself an erudite scholar, took great interest in the science of astronomy and published a catalogue of stars comparing his own observations of their magnitude etc. with those of Ptolemy and al-Sufi, alongwith planetary tables. He erected a large observatory at Samarkand and gathered round him a team of scholars and scientists to make researches. The prominent astronomers of this period were Jamshed al-Kashi and Ali Ibn Mohammed al-Qashji.

Al-Kashi (died 1436 A.D.) was the first director of this observatory and a great mathematician and

1. Muslims Contribution to Science and Culture, M. Abdur Rahman Khan, pp. 57-58.

astronomer of his age. He prepared a number of *Zij* (tables) and maps and made remarkable contributions to this science. His work is *Zij al-Khaqani* (the Tables of Khaqani).

Ali Ibn Mohammad also made his mark in the field of astronomy. He died in 1474 A.D. He remained at Samarkand but travelled to Kirman, Tabriz and other places. In 1437, he prepared the "Tables of Ulugh Beg", which was held in high esteem in the West, and was edited by J. Greaves and T. Hyde, in Persian and Latin, London (1650—1665). Sedillot translated into French the prolegomena of these Tables (Paris, 1846).

With the death of Ulugh Beg the spirit and vigour in the pursuit of research and astronomical observations declined.

The names of two of the most outstanding experts on the making of accurate scientific instruments for astronomical observations cannot be left unmentioned. They were Harun Ibn Ali Harun Ibn Yahya and Hibatullah Ibn Husain Abul Qasim Al-Baghdadi. They were also great astronomers and made some significant observations. Hibatullah is also credited with the invention of Magnetic Needle.[1]

Observatories

Before the Muslims started on the march of civilisation there existed only a few famous observatories in Alexandria. Within a few centuries the Muslims established a large number of well-equipped observatories in most of the centres of learning. Among the famous observatories were:

1) The solar observatory built by al-Mamun in Iraq in 829.

2) The Ispahan observatory built by Abu Hanifah al-Dinawari in 895.

1. Al-Qifti, pp. 438-440.

3) The Khwarizm observatory built by Al-Biruni.

4) The Baghdad observatory of Thabit ibn Qurrah.

5) The Baghdad observatory built by Caliph al-Mustarshid, where the well-known astronomer Badi made his observations.

6) The observatory erected by Ibn Sina.

7) The Al-Raqqah and Antakiyah (Antioch) observatories where al-Battani made observations from 877—918.

8) The Banu Musa observatory opened by the three sons of Musa ibn Shakir (850—870) in their house at Baghdad.

9) The Sharaf al-Daulah (982—989) observatory in his palace at Baghdad where Al-Saghani and Al-Kuhi carried out their astronomical observations.

10) The Tabitala observatory where Abu Ishaq worked and made observations.

11) The Buzjan observatory associated with the name of Abul Wafa.

12) The Muqattam observatory in the neighbourhood of Cairo, built by Al-Hakim, the Fatimid ruler of Egypt (996—1021) who was personally interested in astronomical calculations and used the observatory for astronomical observations. The renowned scholars Ali Ibn Yunus (d. 1009) and Ibn-al-Haitham (al-Hazen) were attached to his court. Al-Hazen found out the law of refraction in transparent bodies; laws of reflection of light, spherical and parabolic aberrations and the law of refraction which later came to be known as Snell's Law[1].

1. History of Muslim Philosophy, Vol. II, p. 1294.

13) The observatory established by Jalaluddin Malik Shah at Rayy (1074) where an important reform was introduced in the civil Calendar by Omar Khayyam.

14) The Maraghah observatory erected by Nasiruddin Tusi (1259). It is said that several kinds of instruments were installed in this observatory, and that a library containing 400,000 was attached to it.[1]

15) The Samarqand observatory built by Prince Ulugh Beg (1394—1449). Qazizade-i-Rumi became the director of an elaborate observatory, built there in 1428, which produced significantly improved astronomical data. He wrote extensive theoretical studies, and several members of his staff, notably Ali Qashji (d. 1474) were, like him, independent mathematical thinkers.[2]

Astronomical Instruments

To accelerate the progress of scientific study and astronomical observations, the Muslims also constructed a large number of instruments. Some of the most important were:

1) *Libnah*, built on a square base, served to measure the declination, latitude, and distances of stars.

2) *Halqah I'tidal* (Meridian Circle), fixed in the plane of the meridian, and devised to determine the distances of heavenly bodies.

3) *Dhat al Autar*, constructed by Taqiuddin, served as an alternative for the Meridian Circle which was useful during night as well as day.

1. *Ibid.*, pp. 1284-1285.
2. History of Mankind, Vol. IV, Part II, p. 813 (UNESCO publication, George Allen and Unwin Limited, London, 1969).

4) *Dhat al 'Alq* (the Astrolabe) was one of the most important instruments. It consisted of two circles, one of which represented the ecliptic and the other the celestial meridian.

5) *Dhat al Samt wal Irtifa* (*Alt-azimuth*) consisted of a semi-circle and had the diameter of an equi-surfaced cylinder. Taqiuddin has mentioned it in his work to have been constructed by Muslim astronomers.

6) *Dhat al-Shu 'batain*. It had three faces on one base and served to determine the altitude of the heavenly bodies.

7) *Dhat al-Jaib* consisted of two faces and was used for the determination of the altitude.

8) *Al-Mushabbah bi al-Natiq* constructed by Taqiuddin and used for determining the distance between two stars.

9) *Tabaqal-Manatiq* constructed by Ghiyasuddin Jamshid and used for determining the position of the stars, their latitudes, distances from the earth, and movements. It was also useful for obtaining data relating to lunar and solar eclipses.

10) *Zarqalah* constructed by Shaikh Ishaq ibn Yahya, generally known as *al-Naqqash al Andalusi* (the Spanish painter). It was a very useful instrument for observing the movement of the heavenly bodies.

11) *Dhat al-Kursi* constructed by Badi of the Astrolabe (*Badi al-Asturlabi*), as described by Abdur Rahman al-Sufi.

12) *Al-Alat al-Shamilah* constructed by al-Khujandi and used for determining the latitudes.

13) *Al-Jaib al-Gha'ib* consisting of a semi-circle the circumference being divided equally.

14) *Suds-i-Fakhri*, a sextant associated with the name of Fakhr al-Daulah Dailami.[1]

15) *Nazara-al-Bu'd* was invented by Al-Kindi for his observatory 750 years before James Metius (1608) of Holland. Al-Kindi in his booklet on Telescopy named: *Risala fi 'Amal Ala Urafa-o-biha Bu'd a-al-Mo'ayanat*) has given its detailed description. Some observations were made about Jupiter, the Sun and other planets of the solar system.

He also invented a telemeter for the measurement of the distance, depths and heights of space, hills, mountains, rivers and oceans. He also calculated the distance from the earth to the moon.

1. History of Muslim Philosophy, Vol. II, p. 1284-86.

CHAPTER 8

Medicine and Surgery

The science of medicine and the art of surgery, the best indicia to a nation's genius, were developed by the Muslims to the highest degree. Medicine had undoubtedly attained a high degree of excellence among the Greeks, but the Arabs carried it far beyond the stage in which their predecessors had left it, and brought it close to the modern standard.[1]

The Muslims made significant contributions in the field of medical research for several centuries. The study of medical substances, the idea of which struck Dioscorides in the Alexandrian School, is, in its scientific form, a creation of the Arabs. They invented Chemical Pharmacy, and were the first founders of those institutions which are now called dispensaries. The persons incharge of the dispensaries were under the control of the Government. The price and quality of medicine were strictly regulated. Many dispensaries were maintained by the State. There were regular examinations for physicians and pharmacists and diplomas or degrees were given to successful candidates. According to Von Kremer and Sedillot the diploma holders alone were entitled to practice.

S. P. Scott is of the opinion that the beneficent science of medicine was in the seventh century degraded by the priest and the charlatan. The writings of the Greek practitioners were forgotten. Throughout Christiandom, medicine was closely allied with sorcery and imposture. It was generally held that disease was a punishment inflicted for the commission of sin.

1. Spirit of Islam, Ameer Ali, p. 386.

These impostors and charlatans employed mummeries, exorcism and incantation. One invoked the intercession of the saints, the other was credited with holding nightly intercourse with the spirits of the infernal world. Both wielded great power and lived in luxury. People were totally ignorant of the commonest rules of hygiene. The houses were unhygienic and unhealthy and water was contaminated.

But in the Orient great progress had been made in various branches of the art of healing. The number of Arab physicians was prodigious. An entire volume of the biographical work of Ibn Abi Usaybiah is replete with their names. The city of Baghdad during the eleventh century was proud of 900 physicians. The Nestorian school of Junde-Shapur produced many eminent practitioners. Harith ibn Keladah, an Arab, established himself at Mecca. The Prophet Mohammad attended the sick and gave consultations. He recognised the importance of hygiene. He said "God has not caused a single disease to descend upon man without providing a remedy; diet is the principle of cure, and intemperance, the source of all physical ills." The Caliph Al-Mamun was the first Muslim prince to give an impetus to the study of scientific medicine. He patronised great professors of Junde-Shapur who were Christians. Under their directions, colleges and dispensaries were established and the foundation of the first hospital was laid at Baghdad. Great search was made all over the world for medical treatises of every description, and the Greek authors were rendered into Arabic.

In medicine, the Spanish Arabs enjoyed peculiar advantages. The accumulated wisdom of the Alexandrian School was theirs by the right of conquest. The learning, the inventions, the methods of the great colleges of Baghdad, of Cairo, of Damascus were theirs by appropriation or inheritance. The enterprising surgeons and pharmacists of Moorish Spain travelled, studied and pursued their investigations in every country which promised a profitable return to their profession and their research. The academies of the Peninsula were illumined by the genius and the erudition of such great writers and practitioners as the Bakhtichons, Masues, Serapion Johannes, and Serapion the Younger. The other pioneers of medicine and surgery were Hunain Ibn Ishaq, Sinan Ibn Thabit, Al-Kindi, Ibn Sina, Abu Bakr Mohammad of Persia, Ibn al-Wafid, Ibn Al-Haitham, Abu Mansur Muwaffaq, Al-Razi, Abdul Latif, Ibn al-Jazzar, Constantine Africanus and Al-Idrisi of Barbary. Some of the leading physicians established their own private institutions. The profession was made hereditary. The Caliphs bestowed upon the physicians the most substantial marks of their favour. Jabril Ibn Bakhtichon left 90 million dirhams and Al-Mamun rewarded Honain for every volume he translated from the Greek weighed in gold.

These men were famous mathematicians, astronomers, metaphysicians, grammarians and botanists. They were specialists who wrote with signal ability on the morbid anatomy of the different portions of the body. Affections of the eye, obstetrics, eruptive fevers were exhaustively treated. The Book of Rhazes on the diseases of children is the first on the topic known to exist. Medical encyclopaedias were common. The number of translators produced by the school of Baghdad alone exceeded one hundred[1].

Hospitals and Medical Colleges

The Muslims established a splendid network of medical institutions—colleges, hospitals, dispensaries and laboratories—in their empire and organised them on the most scientific lines. Important among them were hospitals at Baghdad, Damascus, Rayy, Isphahan, Merv, Samarkand, Shiraz, Cairo, Jerusalem, Alexandria, Qairwan, Fez, Cordova, Valencia, Seville and

1. History of the Moorish Empire, S. P. Scott, Vol. III, Chapter XXVIII.

Toledo. There were general and mental hospitals, hospitals for the lepers and chronic diseases. There were mobile dispensaries as well, for the benefit of the rural population, and military hospitals for the army. They also had First-Aid dispensaries and the first of its kind was founded by Ahmad Ibn Tulun at Fustat in 875. An important hospital was also founded by Sultan Salahuddin Ayubi (Saladin the Great—1138-1193).

As early as 707 A.D. the Caliph al-Walid established infirmaries at Damascus. During the golden age of the Abbasid Caliphs, Harun al-Rashid and Mamun al-Rashid, a chain of hospitals was founded in the great city of Baghdad. Any one who visited this splendid city saw around him a number of large and well-organised hospitals, like 'Aḍudi and Muqtadiri' of high standard with superb cleanliness and prompt and efficient medical attendance. The most magnificent 'Aḍudi hospital (977 A.D.) was well-planned and scientifically organised on the basis of special wards for fever cases, accidental injuries, ophthalmic cases, surgery, and so on. A staff of 44 physicians and surgeons was appointed to carefully look to the medical treatment of each and every patient. A post of Director-General of Health was created at Baghdad to inspect and pay surprise visits to the hospitals to maintain their high standard.

Damascus enjoyed high reputation for well-equipped hospitals and medical facilities. The largest and most famous of them was founded by Sultan Nuruddin. It was also used for the medical college to impart clinical instructions at the bedside, and possessed a very rich medical library.

One of the most famous hospitals of the Islamic world, the Bimaristan al-Mansuri at Cairo established by Sultan al-Mansuri in 1283 A.D., with accommodation for 8,000 persons, was very scientifically planned. It was divided into different wards for special groups

of patients and had a medical store, a mosque and a school. Each ward was placed under the direction of a competent specialist who was appointed for treatment and study of every disease. There was an external arcade surrounding a garden, where fountains splashed and the air was sweet with orange blossoms. The walls of its spacious wards were decorated with green and gold tiles, the windows were filled with jewelled glass, the floors were made of inlaid marble or enamelled brick. Clinic rooms and lecture halls were connected with it. It was a model hospital that not only paid medical attention to the patients but also took care of the social and human aspects of life as well. Traditionally, the management of the hospital gave financial help to the poor and deserving patients in the shape of five pieces of gold at the time of their discharge from the hospital so that they might not suffer from financial stringency.

In Andalusia, there was a reputed hospital, Algeziras, founded in the 12th century. Fifty first-class institutions of this kind existed during the hey-day of Muslim civilisation at Cordova. All these institutions were controlled by the Government and placed under the supervision of the Court Physician, the Civil Surgeon of the modern time. In all hospitals registers of cases were maintained and preserved.

The Muslims were the pioneers in establishing mental hospitals in a well-organised manner. The first mental hospital was founded in Baghdad in 765 A.D.[1] A network of such hospitals was established in the East, North Africa and Spain. According to Neuburger, the mental patients were more humanely and efficiently treated with psychotherapy in Muslim hospital than in the Western countries where they were not considered better than criminals. Undoubtedly, the first hospital for mental cases was established

1. Falk, *Studien uber Irrenheil Kunde Alten*, Allg. Zeits. f. Psychiatrie. 1866, p. 549.

in Europe by the Spanish religious orders of Valencia in 1410 on the pattern of the Cairo hospital, built by the Muslims a century earlier.[1]

Desmaisons confirms this statement and expressed his views thus: "The Moristan of Cairo was founded in the year 682 A.H. (*i.e.*, in 1304). It, therefore, was anterior by at least a century to the foundation of the asylum of Valencia. And it is not considered in the East of a very ancient date.[2]

No course of treatment was approved until it had been repeatedly tested. Al-Razi claimed that his knowledge had been acquired in hospitals and not from libraries. It was the leading principle of the practice of Ibn-Zuhr, that the resources of nature, if properly directed, were generally sufficient to cure a disease. Abul Qasim al-Zahrawi (Abulcasis) insisted that a thorough knowledge of anatomy was indispensable to success in surgical practice. Ophthalmic diseases, endemic in countries subjected to the incessant glare of a tropical sun, received particular attention. The Moorish surgeons describe eleven different operations for cataract. Smallpox and leprosy were the subjects of protracted and exhaustive investigation. There were specialists for affections of the nerves and the brain and of pectoral organs; for complaints resulting from physical excesses and for the various forms of insanity.

The Spanish and Sicilian Arabs were the disseminators of the science of medicine and other branches of practical knowledge. The Continent of Rhazes, the Canon of Avicenna, the Meliki of Ali Ibn Abbas, each a vast compendium of scientific information, whose principles form the basis of all modern practice, were early familiar to the Moorish physician of the Peninsula. The works of Al-Hazen and Ali Ibn Isa

1. L. Mongeri, cited in *Journal de la medecine mentals,* VII, t p. 307, Paris, 1867.
2. Desmaisons: *Des asiles d'alienes en Espagne*, Paris, 1859.

were used by the students of Cordova. Every medical treatise of importance was to be found in the libraries of the Caliphate.[1]

No names in the long list of Muslim genius stand higher than those of Abulcasis (Abul Qasim al-Zahrawi), the originator of modern surgery, Avenzoar (Ibn Zuhr), whose family was prominent for 300 years in the medical world of Moorish Spain, and Averroes (Ibn Rushd), whose great professional attainments have been obscured by his pre-eminent reputation as a natural philosopher. Ibn al-Khatib (the court physician to Abdur Rahman and Al-Hakam II of Cordova) whose works exceeded 1,000 in number, composed treatises on gynaecology, on the hygiene of pregnant women and infants, and obstetrics. He was also the author of the Calendar of Cordova, a wonderful compilation of medical truth, surgical maxims and astronomical and agricultural knowledge. Ibn Al-Wafid of Toledo (d. 1074) devoted twenty years in the preparation of his work on the general practice of medicine. Ibn Zuhr of Seville was the first to discover that scabies was produced by a diminutive parasite, and to prescribe sulphur as a remedy. The treatise of Mohammad Ibn Qasim on the diseases of the eye occupied 600 pages and that of Mohammad al-Temini on hernia and tumors nearly 400. Daud al-Agrebi wrote on fumigation, collyriums and haemostatics. Saladin Ibn Yusuf published a book on the anatomy of the eye and the theories of vision. In aetology, pathology, therapeutics, great progress was made. Whenever possible, the curative powers of nature were allowed full exercise. A change of climate, especially in pulmonary affections, was one of the principal resources of the Moorish physicians. Their work was elucidated by the introduction into the text of drawings of instruments

1. History of the Moorish Empire, S. P. Scott, Vol. III, Chapter XXVIII.

adopted to the removal of the morbid conditions described.[1]

The treatment of the eye received great attention from the Arab physicians and surgeons. The oculists were most accomplished operators. They describe nine different forms of cataract, which they treated by couching and by puncture. Their needles were both round and triangular, some were hollow and made of glass. The Arabs were the first to perform the important operation of lithotomy and to reduce old dislocations. They knew how to ligature the arteries four centuries before Ambrose Pare. They used hooks for the extraction of polypi. The seton is their invention. The application of leeches in apoplexy was a common incident in their practice. They were familiar with the effects of caustics and acids as escharotics. They understood the value of cold water in arresting haemorrhage. They originated the modern methods of bandage. The treatment of fevers, like typhoid, by low-temperature baths was frequently employed by them. It was recommended by Al-Razi 900 years ago. To Ibn Zuhr medical science owes the operation of tracheotomy and the original description of pericarditis, Abul Qasim al-Zahrawi explained lithotomy. Abu Bakr Ibn Badr was the famous veterinary surgeon.[2]

In their contributions to the pharmacopoeia, the Muslims rendered immense service to medicine. Abul Abbas of Seville was the first to apply the botanical principles. Ibn Al-Awwam has mentioned 600 plants having medical properties and Ibn Baytar more than 300.

Dr. Donald Campbell has rightly remarked, "Of all the branches of Arabian medicine, Pharmacy survived the longest. Even today we find the pharmacopoeias of Europe and America are largely founded

1. History of the Moorish Empire, S. P. Scott, Vol. III, and Encyclopaedia of Islam and Ibn Ali Usaybiah, Vol. II, p. 49.
2. S. P. Scott, Vol. III, Spirit of Islam, pp. 385-386 and Dair-al-Ma'arif.

in the Arabic methods of presentation with their tables of weights and measures, and their multitudinous medicaments, and such names as alcohol and elixir which have been derived from Arabic sources.

"The study of medicine in Europe began at Salerno where Constantine, the African, who was lucky in having an Arab for his teacher, organised the first medical school. Montpellier and Paris soon followed suit. Arabic, being the chief medium of scientific thought practically all over the world, was taught systematically in several European universities and schools, especially at Toledo, Narborne, Naples, Bologne and Paris."

It will not be out of place to mention briefly the contributions made by some of the very outstanding physicians and surgeons whose selfless devotion to research and experiments, and dedication to their profession opened a new chapter of knowledge and discoveries hitherto unknown to mankind. Among such personalities are Al-Kindi, Al-Razi, Ibn Sina, Abul Qasim al-Zhrawari and others.

Al-Kindi

Abu Yusuf Yaqub Ibn Ishaq al-Kindi, an Arab philosopher was called Failsuf al-Arab on account of his South Arabian descent. Born in the middle of the ninth century A.D. at Kufa where his father was the Governor, he was educated in Basrah and Baghdad, then the great centres of learning. He served in various capacities at the Abbasid Court, especially under Al-Mamun and Al-Mutasim as translator and editor of Greek masters into the Arabic language. At the Abbasid Court he was appointed as Court Astronomer and Physician.

Al-Kindi wrote more than twenty books on medicine. He made an extraordinary attempt to establish Posology (the science of doses) on a mathematical basis in a work which was translated into Latin and published

in Strassburg in 1931. He also dealt in detail with optics in the book which has been a great source of information for the physicians in the East and West alike.[1] His treatise covers four principles of vision, (1) the passage of light in straight lines, (2) the direct process of vision, (3) the process of vision by a looking glass, and (4) the influence of distances and angle of vision on sight along with optical delusions.

Eclectic in the sense of later Hellenism, Al-Kindi regarded the Neo-Pythagorean mathematics as the basis of all sciences, and endeavoured in the Neo-Platonic fashion to combine the views of Plato and Aristotle.

He was fond of applying mathematics not only to physics, but also to medicine. He explained the effect of these medicines from the geometrical proportions of the mixture of physical qualities, warm, cold, dry or moist. He is, therefore, still regarded by Gardan Girolamo, a philosopher of the Renaissance, as one of the twelve subtlest minds.

Al-Razi

The later physicians succeeded in replacing the works of Galen and Hippocrates for several centuries and substituting their own at the universities. Of this class of original writers the oldest is Mohammad Ibn Zakariyya Al-Razi (Rhazes). He was born in 865 A.D. at the ancient town of Ray (near modern Teheran), the principal city of the north-east part of the Jibal province of Persia. In his early youth he studied music (on which he wrote an encyclopaedic work), philosophy and logic. But in his early thirties he evinced keen interest in the medical profession and visited the Baghdad hospital several times to be fully conversant with the methods of treatment at the hospital.[2]

1. Ibn Abi Usaybiah, Vol. I, pp. 206—214; G. Sarton, Vol. I, pp. 559-60.
2. Ibid., pp. 309—321.

He acquired learning from great masters but with his industry and intelligence he soon surpassed his teachers, and after a short time was appointed Superintendent and Chief Physician at the Ray hospital. In addition to the heavy duties which these posts entailed, Razi had also to undertake the training of the medical students. In the Muslim fashion, the master sat on the floor in the great, cool, paved courtyard, with his pupils around him. In the innermost ring were the seniors, while the juniors sat beyond in an outer ring. When a patient came for treatment, he had first to describe his symptoms to the elementary students. If the latter understood the case, they prescribed for it, otherwise the patient was passed on to the "second year men". One may assume that there was very little beyond the powers of these young men, but if even they could not handle the case it was taken over by Razi himself.

Such was the fame of Razi as an administrator and physician that sometime during the reign of the Caliph Al-Muktafi (902—907) A.D., he was offered the post of director and chief physician at the Baghdad hospital which he accepted. How long he held this office is not known, but he seems to have travelled a great deal, attending the Persian nobility and even the Caliphs themselves[1].

Razi died in his native town on 26 October, 925 A.D. at the age of 60 years and two months. He was liberal, generous, courteous and affable to everyone, and exceedingly kind to the poor. The ablest physician of his age, Razi was a keen student of earlier authorities. "His chief anxiety and care were to study what the most famous learned men, such as Hippocrates and Galen, had written in their works, so that he made himself master of such knowledge as falls to the lot of very few physicians".

1. Al-Qifti, 368-375; Al-Fihrist; pp. 299-302 and Ibn Khallikan, Vol. III, pp. 311—314.

The Muslim physicians were expert in the art of psychotherapy, and a story told of Razi in this connection is amusing enough to be related here. A certain *Emir* was incapacitated with severe rheumatism, which his own medical attendants were unable to cure. He, therefore, summoned Razi, who, after unsuccessfully trying several methods of treatment, finally said that he would try a new treatment but that it would cost the *Emir* his best horse and his best mule.

The terms were accepted and the horse and the mule were handed over to Razi, who then took the *Emir* to a Turkish bath (hammam) outside the city and went into the hot room with him. After a suitable time had elapsed, during which draughts and douches were administered to the patient, Razi went out, dressed, and returned with a knife in his hand. The startled *Emir* was amazed to hear a torrent of abuse pouring from the lips of the eminent physician, but when Razi at length brought the matter to a climax by threatening to kill him, the *Emir's* fear and anger knew no bounds. He sprang to his feet in order to summon the guard forgetting all about his rheumatism. But Razi had fled to the outer door of the bath, where his servant was waiting with the horse and the mule. They did not stop until they crossed the frontier. Razi afterwards wrote and explained that his provocative words and acts were designed as a part of the treatment, and the *Emir*, who was completely relieved from the ailment, had grace enough to see the humour of the situation. He rewarded his ingenious healer with many rich presents and assigned him a yearly pension equivalent to £ 1000 and 200 donkey-loads of corn.

According to Prof. E.G. Browne, "Al Razi was the greatest and most original of all the Muslim physicians, and one of the most prolific as an author".[1] Prof.

1. Arabian Medicine, p. 44, Encyclopaedia Britannica, Vol. 19, p. 245.

E.J. Holmyard thinks, "Conspicuous among these Muslim Chemical physicians stands the great figure of Rhazes, who though he differed from Bombastes as widely as possible in temperament and character, may well be called the Paracelsus of Persia, since he taught and practised the study of chemistry as a valuable aid to medicine." His erudition was all embracing and his scientific output remarkable, amounting to more than 200 works, half of which are medical. He also wrote a monumental work, *Kitabul-Mansuri* in ten volumes of which a Latin translation appeared in Milan in the eighties of the fifteenth century. Parts of it have been rendered into German and French. One of the most celebrated of his monographs is that on "Smallpox and Measles" (*al Judari-Wal-Hasbah*). It was first translated into Latin in 1565 and later into several European languages, including English and went into forty editions between 1498 and 1866. According to Prof. P.K. Hitti "This treatise served to establish Al-Razi's reputation as one of the keenest original thinkers and greatest clinician not only of Islam but of the Middle Ages[1]. The most important medical work of Al-Razi was *al Hawi* (the Comprehensive Book), an encyclopaedia in the annals of medical information. It consists of more than twenty volumes. In each chapter on the individual diseases he quotes all the Greek, Arabic, Persian and Sanskrit authorities and then describes his own views based on practical experience, giving evidence of his erudition and insight. It was translated into Latin under the auspices of Charles I of Anjou by the Sicilian Jewish physician, Faraj Ibn Salim (Farragut) of Girgenti, in 1279 and was repeatedly printed from 1486 onwards. These works of Razi exercised a remarkable influence on European medicine.

European scholars credit Razi with having given a better account of the curvature of the spine than any other author upto his time. He is also admitted

1. History of the Arabs, p. 366.

to be the first writer of a book devoted to the diseases of children, the first to maintain that disorders of the bladder are accompanied by blood in the urine.

Dr. Robinson calls Al-Razi a genito-urinary specialist. In his writings on gonorrhea he gave a detailed description of strictures and, if these produced any degree of retention of urine, he at once introduced the catheter, for he was a master of the principles of catheterism. To avoid obstruction from blood and pus, he bored numerous holes in the sides of the extremity which enters the bladder. Not finding the classical bronze catheter sufficiently flexible, he invented one of lead.

Al-Razi was the first who consistently used injections. To abate the smarting pain during urination he employed injections of tepid vinegar, or treated the bladder with injections of opium dissolved in rose water. He realised the need of relieving the inflammation and prompt healing of the urethra by local means and by internal medicaments. It seems that a gonorrheic was as safe in the hands of Al-Razi as in our own.

All his works on physics, mathematics, astronomy and optics, of which a large number are enumerated by the bibliographers, have perished.

Al-Biruni frequently refers to Razi's works. He also devoted a complete *risala* (tract) to a study of the life and works of Razi.[1] He lists the books of Razi as he knew them. He divides them, according to P. Kraus edition, into the following classification of books, brochure or letters:—

1.	Medicine	56
2.	Natural Sciences (dealing with matter, space, time, motion, nutrition, growth, putrefaction, meteorology, optics and alchemy)	33

1. Encyclopaedia of Islam, Vol. III, p. 1135.

3.	Logic	7
4.	Mathematics and Astrology	10
5.	Interpretations, summaries and resumes	7
6.	Philosophy	16
7.	Metaphysics	6
8.	Theology	14
9.	Chemistry	21
10.	Aesthetics	2
11.	Fine Arts	10

Al-Razi left his mark on surgery also. He was the inventor of the seton. His interest in physics is evident from his investigations on the determination of specific gravity by means of the hydrostatic balance, called by him *Mizan-al-Tabi'i* and his book *Kitab-al-Asrar* displays his keenness on chemistry as well, through his description of chemical processes and apparatus. He is held to be the greatest physician of Islam, indeed of the whole world during the Middle ages.

Sinan Ibn Thabit

Sinan, a convert to Islam, is an important name in the history of Arab medicine. He was a physician successively to Al-Muqtadir, Al-Qahir, and Al-Radi at Baghdad and earned great reputation for his brilliant administration of the famous hospitals of Baghdad and for his admirable efforts to raise the scientific standard of the medical profession.

Under the influence of Sinan, no medical man was allowed to practise in Baghdad without undergoing an examination and procuring a diploma.[1]

Ibn Sina

The most outstanding and illustrious personality in the domain of medical science after Al-Razi is that of Ibn Sina, universally known to the West as Avicenna

1. Ibn Abi Usaybiah, Vol. I, pp. 220-224 and Al-Qifti, pp. 274-280.

(980—1037 A.D.) and called Al-Shaykh-Al Rais by the Arabs. After studying the Quran, Arabic literature, logic, mathematics and astronomy, he devoted his time to the study of physics, metaphysics and medicine and soon earned a wide reputation as a successful physician.

In the sixteenth year of his age he was giving tuition to eminent physicians who came to him to study different branches of medicine, and learn from him the modes of treatment which he had discovered by his practice. During the period of his studies he never slept an entire night, nor passed a day in any other occupation but study. He had not reached his eighteenth year when he had completely mastered all the sciences to the attainment of which he had directed his studies.[1]

It was after his establishment as a physician that he happened to see one of Al-Farabi's philosophical works. This, according to De Boer, decided his philosophical development. Al-Farabi's metaphysical and logical speculations, which originated in the Neo-Platonic commentaries and paraphrases of Aristotelian works, determined the direction of his thought, at the age of sixteen or seventeen only.

At a very young age Ibn Sina received a commission for the medical treatment of Nuh Ibn Mansur, the Sultan of Bokhara. Here he happened to secure admission to the Royal Library which was of incomparable richness as it contained not only all the celebrated works which were found in the hands of the public, but others not available anywhere else, and whose contents and even the titles were unknown. He discovered treatises on the sciences of the ancients (the philosophical doctrines of the Greeks) and became acquainted with them. With his wonderful memory and sharp power of assimilation he ransacked all the

1. Ibn Khallikan, Vol. I, pp. 440-46.

treasuries of knowledge which enabled him to systematise the learning of his time.[1]

At the age of 21, Ibn Sina made a mark as a writer of eminence. He wielded a powerful pen with a clarity of style and diction and a comprehensive system. Among his scientific works the leading two are "*Kitab-al-Shifa*" (Book of Healing) and *Al-Qanun fit Tibb* (the Canons of Medicine) which is the culmination and masterpiece of Arabic Systematisation. This medical encyclopaedia deals with general medicine, simple drugs, diseases affecting all parts of the body from head to foot, specially pathology and pharmacopoeia. This work reveals that he possessed a wonderful power of observation as is evidenced from his remarks on the distinctions of Mediastintis from Pleurisy, the contagious nature of Phthisis and the spreading of diseases by water and soil, etc.[2]

Ibn Sina gives a vivid description of the skin and deals comprehensively with the diseases of the sexual organs and the nervous system. He has outlined pharmacological methods on almost modern lines and his materia medica contains no less than 760 drugs.

Dr. Robinson observes, "the Canon of Avicenna, consisting of approximately a million words, is the most influential text book ever written; for six centuries it dominated the medical schools of Asia and Europe."

Ibn Sina was the first to use catheters made of skins of various animals, and mentions intravesical injections by means of a silver syringe. He expressed advanced views on hygiene and physical culture. He dealt exhaustively with the intra-uterine development of the human embryo.

In surgery Ibn Sina made an allusion to intubation of the larynx and described the tracheotomy.

1. Ibn Abi Usaybiah, Vol. II, pp. 3—20.
2. *Dayra-al-Maarif* Islamia and Hitti, p. 368.

He further described operations for empyema with cautery or knife, for piles and fistula by ligature. In the discussion of dislocations he included a method of reposition of the head of humerus. He also knew and practised the method of treating spiral deformities by forcible reduction which was reintroduced by Calot in 1896.

Ibn Sina described the symptoms of pyloric stenosis and of gastric ulcer. His description of diseases of the liver and the gall bladder are remarkable. He also left excellent description of respiratory diseases and gave a scientific account of the differential diagnosis of pleurisy. He distinguished between true meningitis and meningism which may accompany certain acute diseases. With regard to facial paralysis, Ibn Sina distinguished the central and peripheral types. He very well knew the movements of contraction and dilatation of the pupil and discovered the insertion of the eye-muscles. He further knew the functions of the lachrymal ducts.

The *Qanun* was published in Arabic in Rome in 1593. It was translated into Latin by Gerard of Cremona in the 12th century. It became the text book for medical education in the schools of Europe. The demand for it may be judged from the fact that during the last 30 years of the 15th century it was issued sixteen times—fifteen editions being in Latin and one in Hebrew, and that it was reissued more than twenty times during the 16th century. In 1930, Cameron Gruner partly translated this book into English, called, "A Treatise on the Canons of Medicine of Avicenna". From the 12th to the 17th century the *Qanun* served as the chief guide to medical science in the West. Dr. William Osler, author of the Evolution of Modern Science, has rightly remarked, "the *Qanun* has remained a medical Bible for longer period than any other work."

Ibn Sina was unquestionably the most gifted man of his age. A philosopher, mathematician, astronomer,

poet and physician, he has left his influence impressed on two continents.

Ibn Al-Jazzar

He was the famous physician of Qairuwan in Tunisia and wrote a learned medical work, known as the *Zad al-Musafir*, which contained a remarkable description of small-pox and measles. He also wrote on the Coryza and on the causes of the Plague.

Ibn Al-Wafid

This Muslim pharmacologist of Spain in his *Kitab-al-Adwiya al-Mufrida* advocated the use of dietetic measures in the treatment of diseases, and if drugs were at all needed, he urged that the use of the simpler ones should be resorted to. He is credited with having discovered a method for the investigation of the action of drugs. He also wrote on balneotherapy (Treatment by Baths). He held high position in the hospital at Toledo.[1]

Ibn al-Khatib

Ibn al-Khatib of Granada (1313—1347) was a well-reputed physician, and enjoyed an eminent position for his remarkable treatise "On Plague", which included description of the great plague of the 14th century. In this book he had scientifically analysed the epidemic as a contagion and not a divine punishment.

"The existence of contagion is established by experience, study and evidence of the senses, by trustworthy reports on transmission by garments, vessels, ear-rings, by the spread of it by persons from one house, by infection of a healthy sea-port by an arrival from an infected land..... by the immunity of isolated individuals and.....nomadic Beduin tribes of Africa..... It must be a principle that a proof

1. Ibn Abi Usaybiah, Vol. II, p. 49; Al-Qifti, pp. 313-314.

taken from the Traditions has to undergo modification when in manifest contradiction with the evidence of the perception of the senses".

This is definitely a great and significant advance on the Greek physicians who laid very little emphasis on this aspect of medical treatment.

Zarrin Dast

He was another ophthalmologist of the 11th century who flourished at the Court of Malik Shah, the Saljuki Sultan. He compiled a treatise on ophthalmology which is described by George Sarton as "very comprehensive and very remarkable".

Ismail Al-Jurjani

He was the royal physician at the Court of Khwarizm, and produced about the year 1100 A.D. the famous Persian medical encyclopaedia known as the *Zakhire-i-Khwarizm Shahi*. This work is unique in having been translated in the Hebrew language.

It contains no less than 450,000 words and is divided into nine books, 75 discourses, and 1,107 chapters. A copy of this unique manuscript is in the possession of a Hazara (Pakistan) landowner whose grandfather had picked it up from the waters of the Sind river during the 1840 floods.[1]

Ibn Hibatullah

He was born a Jew and is believed to have married the sister of Maimonides. Undoubtedly, Hibatullah and his wife and almost all their children embraced Islam. He was the physician of Salahuddin (Saladin), and after the death of the latter, of his brother Al-Malik al'Aadil. Ibn Usaybiah in his book speaks highly of his erudition, generosity and powerful influence at Court.[2]

1. The *Dawn*, Karachi, December 4, 1949.
2. Islamic Culture, Hyderabadd (Inia), Vol. I, No. 3, July 1927, p. 401.

He lived at Fustat (Cairo) at the end of the 12th century and was the author of a surgical treatise, *al-Mujabbir* (The Bone-Setter), in which he had given accurate descriptions of the joint bones of the heel, the hand and the back, etc.[1]

Al-Haytham

Optics was developed to its highest degree by Abu 'Ali al-Hasan Ibn-al-Haytham (Al-Hazen) of Basra (965—1039 A.D.) He is recognised as the greatest Muslim physicist and one of the greatest students of optics of all times. He explained binocular vision. He also determined that the retina is the seat of vision and that the impressions made by light upon it are conveyed along the optic nerve to the brain.

His books on the subject are "On Optics", his major work, and *Kitab al-Manazir* (Book on Optics). The original books in Arabic are lost but they survive in Latin.

Al-Haytham opposes the theory of Euclid and Ptolemy that the eye sends out visual rays to the object of vision. He discusses the propagation of light and colours, optic illusions and reflections. He examines also the refraction of light rays through transparent mediums (air, water). In detailing his experiments with spherical segments (glass vessels filled with water), he comes very near to the theoretical discovery of magnifying lenses which was actually made in Italy three centuries later, while more than six centuries were to pass before the law of sines was established by Snell and Descartes. Roger Bacon (13th century) and all medieval western writers on optics, notably the Pole Witelo or Vitellio, base their optical works largely on Al-Hazen's *Opticae Thesaurus*. His work also influenced Leonardo da Vinci and Johann Kepler.[2]

1. Ibn Khallikan, Vol. III, pp. 580-82, Ibn Abi Usaybiah, Vol. I, pp. 283—290 and Al-Qifti, pp. 443-44.
2. Legacy of Islam, pp. 333-334, Encyclopaedia of Islam, Vol. II, p. 382.

Federico Risnerio was the first to translate *Kitab al-Manazir* in Latin. It was published in Basle in 1572. A century later the first book on the subject was written in the West by Sir Isaac Newton.

Risnerio got an illegible manuscript of the book from P. Ramus and devoted a whole year to correct and compile it with the help of another copy. He divided the first book in propositions, corrected their proofs and added to them the fundamentals which were missing, taking them from Euclid, Theodosius, Apollonius, Serenus and other Geometrician. Finally he gave to the book a Greek name and dedicated it to Catherine Medici, Queen of France.

The Muslim scholar, Kamaluddin Abul Hasan al-Farsi, took interest in Al-Haytham's book "On Optics" much earlier than the Latin speaking West. He wrote two voluminous commentaries in Arabic in 1320 and named it *Tanqeeh al-Manazir*.

Al-Farsi first studied the optical problems, dealt with by Euclid, but not satisfied with his writings, he perused Al-Hazen's book which deeply impressed him and stirred his mind to make a critical study of the book.

The most important question which perplexed him was, "How did the eye receive images particularly on refraction (he actually observed that the objects seen through water or from across a rock crystal took all sorts of shapes)"?

He could find no answer to this question in Euclid and on the recommendation of Qutbuddin al-Shirazi he read Al-Hazen's book "On Optics".

This monumental work greatly satisfied Kamaluddin in which he found with clarity the exposition of the problem, supported by geometrical proofs, observations and a number of useful propositions.

In this excellent commentary Kamaluddin has added a complete series of original ideas to those of his predecessor.

Besides this scholarly book "On Optics", the great Arab scientist wrote no fewer than 44 books on philosophy, geometry, astronomy and mechanics.

In his treatise on "Light" he says that light is a kind of fire, reflected at the spheric limit of the atmosphere.

In Twilight Phenomena, which is extant only in Latin, he maintains that this atmosphere is about 10 miles in height. His other works deal with the rainbow, the halo, the spherical and parabolic mirrors, shadows and eclipses.

He also put his calculations into practice by constructing mirrors of metal. The bulk of his works were produced in the last decade of his life.

He outclassed the Greeks in creating a dioptric in his work "On Burning Glass", which shows the profundity and accuracy of his conception of the nature of focusing, magnifying inversion of the image and formation of rings and colours by experiments.

Ammar Ibn Ali Al-Mausili

Al-Mausili was one of the leading ophthalmologists of the Middle Ages and flourished in Egypt at the court of Al-Hakim. He wrote the well-known work on ophthalmology, the *Kitab-al-Muntakhab fil Ilajul Ain* (the Chosen Book on the Treatment of Eye Diseases), which contained many clear descriptions of the diseases of the eye and their treatment. He describes six different operations for cataract alone, one of them being for soft cataract by suction through the hollow needle invented by himself. His book was translated into Latin and also in German. Hirschberg considers him the most competent eye surgeon of the whole Arabian world.

Ali Ibn 'Isa

Ali's reputation rests on his well-known oldest Arabic work on ophthalmology, *Tazkirat-al-Kahhalin*, which was early translated into Latin and Hebrew, but the original text is extant. The first book of this work deals with the anatomy and physiology of the eye, the second with the diseases externally visible and the third with the hidden diseases and dietectics and general medicine from the ophthalmological view point.

Ali has described 130 diseases of the eye and 143 drugs used in the treatment of those diseases.

It has been established by Julius Hirschberg in his valuable and masterly history of Ophthalmology that the Muslim surgeons carried out skilfully and successfully every operation of the eye which is performed in modern times.

The Arabs made remarkable progress in surgery. They performed scores of original operations unknown to the ancients. They used tare successfully before undertaking painful operations so that the patient may not feel the pain. They spoke favourably of a process by which blood could be transfused into veins—an operation, as the medical world is aware, cannot be successfully performed without the modern method of "Injection". They were also familiar with the technique of introducing food into stomach through tubes made of silver. They introduced many delicate surgical instruments, used anaesthesia before any major operation and performed amputations of uvula and nasal polyps, tonsileectomy, paracentesis of the drum of the ear, excision of the whole tongue for malignant growths and removal of the diseased bone from the skull, replacing it by a piece of bone from the skull of a dog for treatment of Osteomyeeitis of skull. Al-Zahrawi performed what is now known as cranioclasty for delivery of a dead foetus.

Abul Qasim Al-Zahrawi

Abul Qasim (Abulcasis in Latin), Court physician to Al-Hakam II of Cordova, was the greatest surgeon in the annals of Islam. He was born at Al-Zehra near Cordova in 936 and died in 1013 A.D. He skilfully performed major operations with cautery and knife without the least hesitation.

He wrote an encyclopaedia of medicine, *Kitab Al-Tasrif*, a great medical *vade mecum* in 30 treatises. The first two contain several chapters on the anatomy of the human body. The following 28 treatises are devoted to medical therapy, pharmaceutical preparations, dosage forms and techniques, treatment of diseases, diet and general hygiene, drug synonyms, uses and properties, and weights and measures. His studies in medicine justify his place among the famous physicians and pharmacists of the Middle Ages.

But Al-Zahrawi is chiefly remembered for his thirtieth treatise on Surgery, *Fil 'Amal bi al-Yad*, translated into French by Lucien Leclerc (Paris, 1861). The original ideas and personal observations contained in this treatise revived interest in a neglected field of medicine and proved to be of the highest significance in the history of surgery. It describes, for example, the use of various types of threads for binding wounds and points, for the first time, and the dangers associated with amputations above the knee and elbow. It warns against injuring veins through ignorance or lack of skill while operating, and gives the first explanation of a type of haemorrhage which is difficult to check—a disease known today as haemophilia. It mentions spinal paralysis caused by injury to the medulla and skilfully describes multiple, retained foetus in pregnancy, and performance of cranioplasty on the foetus with illustrations of the instruments used. Furthermore, it is the first treatise to mention the Walcher's position in obstetrics and to describe instrumental delivery in parturition. It also explains in

detail the duties and techniques of midwifery and obstetrics. It recommends treatment for a fractured pelvis and reveals the possibility of entering the external auditory canal by incising beneath the ear.

The most valuable and interesting part of the book is the 200 illustrations of surgical and dental instruments included in this treatise. As illustrations for the instruction of students or guidance of surgeons in making instruments for their particular needs, these are the earliest of their kind. A majority of these instruments which he has drawn and recommended he had personally devised and used on his own patients at the bedside and on the battlefield. His *Tasrif* as called by Haller is Common Fountain of modern medicine.

According to Dr. Robinson, Abul Qasim appears to have been the inventor of the sponge-tipped probang for dislodging foreign particles from the gullet, of the grooved probe for urethral investigation and of the ear syringe.

The Muslims held high distinctions in surgery. The people relied on the prescription of their physicians or on the knife of their surgeon at a time when the Western world was not at all conversant with these sciences.

The surgical portion of *al-Tasrif* was translated into Latin by Gerard of Cremona, prince of Latin translators, from Arabic. Various editions of the work were published in later times, at Venice in 1497; at Basle in 1591, and at Oxford in 1778 and served as text books.[1]

Even Muslim women knew the cure for bleeding; they used certain herbs for cleansing a wound while the remedy for its cure was butter mixed with henna, the peel of an onion and some resins. In dressing

1. History of the Arabs by Hitti, p. 577, and Encyclopaedia Britannica, Vol. I, p. 71.

up wounds they successfully used aromatic herbs, pounded and sprinkled with salt and pepper. Among the most outstanding women physicians were the daughter and grand-daughters of Ibn Zuhr.

At a time when there were no dentists in Europe and America who knew painless extraction of teeth and could prepare germ-killing dentifrice, the Muslims had their skilful dental surgeons who employed opium and dentifrice, to relieve pain. They made a distinct advance on the Greeks. Abul Qasim recognised pyorrhoea. The technique of filling the cavities of decayed teeth with gold foils and the use of arsenic were also known to the Muslims.

A number of illustrations are known of instruments used by Abul Qasim for shaking, loosening and removing teeth, the earliest type of turn-key for extraction, dental saw and file, set of fifteen dental scrapers, small axe for resection of irregular teeth, elevators and forceps for extraction of roots, vulsella for removal of portions of the jaw, and the gold and the silver wire with which he bound a loose tooth to a sound one. He realised that irregular or projecting teeth are particularly displeasing in women, and described the operation for their correction. Undoubtedly, he was a pioneer in discussing oral deformities, dental arches, formation of tartar, replanting teeth and artificial teeth.

One of his works, which deals with the preparations obtained from minerals, plants and animals, represents an early example of chemistry applied to the practice of medicine.

According to Dr. Donald Campbell, Abul Qasim exercised tremendous influence on Western medicine. The most dominant influence of this genius on the medical system of Europe was that his lucidity and method of presentation animated a new spirit in favour of Arabic literature among the scholars of the West. His methods eclipsed those of Galen and maintained

an eminent position in Medieval Europe for 500 years. He helped to raise the status of Surgery in Europe.

And again his descriptions of operations are clear and specially valuable because they portray the figures of surgical instruments used in the Middle Ages.

He was the first scholar who wrote an account of haemophilia, the peculiar condition which females transmit to their male offspring alone. He is also reputed to have made the cautery the "national instrument" of the Arabs. He has mentioned, in one of his works, 50 diseases which he himself treated with fire.

There is no doubt, Abul Qasim exercised a far-reaching influence on the development of Western surgery. Guy de Chauliac, the father of French surgery, quotes Abul Qasim in his works on surgery more than 200 times, and Lefranc (Lanfranchi of Milan), who studied Abulcasis before he became professor of surgery at Paris (1290 A.D.), declared that the surgeons of Paris at that time were so ignorant that one could hardly find among them a single rational surgeon.

Ali Ibn Al-Abbas

Ali Ibn al-Abbas, known to the West as Haly Abbas, flourished fifty years later than Al-Razi. He was Persian by birth and died in 994 A.D. His monumental work, the medical encyclopaedia, *Kamil-al-Sina'ah al-Tibbiya* (The Whole Medical Art), comprises 20 volumes, on the theory and practice of medicine and contains remarkable contributions to dietetics, materia medica and surgery. To the Latins it is known as *Liber Regius*. He dedicated this publication to the Buwayhid *Amir* 'Adud-ad-Dawla. It was translated into Latin in 1227 and printed at Lyons in 1523 by Michel Capella. Ali Ibn al-Abbas corrected many of the errors of Hippocrates and Galen.[1]

1. Spirit of Islam, Ameer Ali, pp. 385-386, Ibn Abi Usaybiah, Vol. I, pp. 236-237.

Ali gave a conception of the capillary system and proofs of the motions of the womb during parturition (child-birth) whereby the child does not come out but is pushed out of the mother's body.

The second and third discourses of Ali's book deal with anatomy and the ninth book of the second part is about surgery. In this book he has described the anatomy of the brain with great minuteness and details.

The surgical technique of Haly Abbas is no less remarkable. His lucid description of the surgical operation for the removal of tubercular glands is a fine specimen of his art. He says: "Cut the skin longitudinally down to the gland. Retract the skin with hooks. Dissect slowly and gently, freeing the gland from the tissues around it. Take care not to cut any vessel or puncture any nerve. If a vessel is cut, ligate it, lest the haemorrhage obscure the field and prevent you from carrying out a proper and thorough operation. After removal of the gland, put your finger into it to feel for any small glands that might be left. If there are any, remove them too. When all the glands are removed, suture the incision."

Haly Abbas recognised the gravity of cancer and says that medicines do not help in curing the disease. He suggests removal of the whole area affected by cutting at a distance from the growth so that none of its roots are left. And he advises that after removal, blood should not be stopped from running but that the surgeon should see that the diseased blood is drained off.[1]

Abu Mansur Muwaffaq

Abu Mansur flourished at Herat during the reign of the Samanid Prince Al-Mansur I (961—976) and was

1. Al-Majusi, Kitab al-Maliki, Vol. II, p. 467 and Khairullah. Outline of Arab Contributions to Medicine and Allied Sciences, p. 118 (Beirut, 1946).

the first to compile a treatise on *materia medica* in Persian. Max Meyerhof thinks that he wrote in about 975 A.D. a treatise, *Kitab-al-Abniya 'an Haqa'iq al-Adwiyah* (The Foundations of the True Properties of Remedies), describing 585 drugs. He also gave an outline of a general pharmacological theory. He knew the toxicological effects of copper and lead compounds, the depilatory virtue of quicklime, and the composition of Plaster of Paris and its surgical use.[1]

Ibn Zuhr

Abu Marwan Abdul Malik Ibn Zuhr belonged to the family of which all the members were either men of learning (in law), chiefs (in the civil administration), physicians or *Viziers:* they obtained the first office in the State, enjoyed the favour of sovereigns and exercised great authority.[2] He was one of the outstanding surgeons of his age. He is known to the Europeans by the name of Avenzoar. He was born at Seville between 1091—1094 and died in 1161 A.D. After receiving an excellent education in literature, law and theology, his father taught him medicine. He soon became equal in knowledge to his teacher and distinguished himself by his original experiments in therapeutics. Like his father, he was at first in the service of Almoravids and later on the Almohads. Ibn Rushd was on intimate terms with him and considered him the greatest physician since Galen. On the death of Ali Ibn Yusuf Ibn Tashufin and the overthrow of the Almoravids, Ibn Zuhr went over to Abdul Mumin. He was given rich presents and received the rank of *Vizier*. Among his works may be mentioned the *Kitab al-Iktisad fi Islahi al-Anfus W'al Adjsad*, and *Kitab-al-Taisir fil Mudawat W'al Tadbir*.

Al-Taisir (Facilitation of Treatment) is one of the most important books of Ibn Zuhr in the annals of medical science. It is a treatise on practical medicine,

1. Legacy of Islam, p. 331.
2. Ibn Khallikan, Vol. III, pp. 134, 138.

pathology and therapeutics and is very valuable because of many clinical descriptions it contains. It has exercised considerable influence on European medicine, which lasted till the end of seventeenth century, through its translation into Hebrew in 1280 and Latin by Paravicius whose version has undergone several editions.[1]

In him we find not only original views on established facts, but new contribution to knowledge also, such as the description of the mediastinal tumours and the abscess on pericardium; diseases which had not been previously mentioned. He was the first Arab physician to recommend tracheotomy. He also practised this on animals in order to study the subsequent phenomena. He discovered the itch mite (*acarus Scabiei*) and treated scabies, and gave an excellent description of leprosy. He was the first to discuss cancer of the stomach, corneal opacities and pannus. Artificial feeding either through the gullet or through the rectum was not unknown to him and he explains its working with much skill.[2]

Ibn Zuhr joined, like Abulcasis, the practice of medicine with surgery. He was the first to conceive the idea of bronchotomy, with exact indications of the luxations and fractures, and discovered several important maladies with their treatment. His son following in his father's steps was the chief surgeon and physician of Yusuf Bin Tashifin's army.[3]

Max Neuburger places him very high in the annals of medical science, and remarks: "Certain of Avenzoar's statements indicate an anatomical trend of thought in surgical matters. He explicitly states that he made a study of osteological preparations. He expresses himself, in particular, upon the indication for the technique of certain surgical operations with

1. Oriental Biographical Dictionary, p. 10.
2. Ibn Khallikan, Vol. III, p. 134-138.
3. Spirit of Islam, Ameer Ali, p. 380; Ibn Abi Usaybiah, Vol. II, p. 64.

a thorough certainty which could not have been acquired except through practical experience, whilst his therapeutic recommendation bespeak an excellent acquaintance with pharmacy."

Ibn Zuhr's daughters and grand daughters were capable mid-wives. Medicine went into the family for six generations. Ibn Zuhr's influence on western medicine lasted till seventeenth century, through his Hebrew and Latin translations.

Abdul Latif al-Baghdadi

Abdul Latif al-Baghdadi (1162—1231 A.D.) made a scientific study of human skeletons accidently discovered in a large pit at Al-Maks (Egypt) and made note of much important facts.[1] It was at Salerno and especially Bologna that forensic studies grudgingly gave sanction to performing operations on the human corpse and thus contributed to the acquisition of sound knowledge of anatomy and surgery.

As a student of anatomy, Abdul Latif greatly contributed to the study of human bones. He was the first physician who gave a correct description of the human skull and facial bones including the lower jaw and corrected many wrong notions of the Greeks in this sphere.[2]

Ibn Al-Baytar

Ibn Al-Baytar was the most outstanding botanist and herbalist of Islam. He belonged to Baytar family of Malaga and was born towards the end of the 12th century. As his teacher of botanical subjects, special mention should be made of Abu-al-Abbas al-Nabati, with whom he used to collect plants in the vicinity of Seville. At about twenty he set out to travel through North Africa, Morocco, Algiers and Tunis to study botany. Reaching Egypt where

1. George Sarton, Vol. II, p. 599.
2. Ibn Abi Usaibiyah, Vol. II, p. 133.

Ayyubid, al-Malik al-Kamil was then reigning, he entered his service and was appointed "Chief Botanist". On Al-Kamil's death he continued in the service of his son Al-Malik al-Saleh Najmuddin who lived in Damascus. Ibn Baytar studied botany in Syria and Asia Minor as a herbalist. The results of his studies and practical research have been compiled in two books. His *Kitabul Jamiul Mufradat al-Adwiya wal Aghdhyia* is a collection of simple remedies from the animal, vegetable and mineral worlds collected from Greek and Arabic authors and his own experiments, and arranged in alphabetical order. In the words of George Sarton, "It is the foremost Arabic and Medieval treatise of its kind, the greatest from the time of Dioscorides to the middle of the sixteenth century, Parts of its Latin version were printed in 1758 at Cremona."[1]

There is no doubt, "In Botany the Muslims advanced far beyond the state in which it had been left by Dioscorides, and augmented the herbalogy of the Greeks by the addition of two thousand plants. Regular gardens existed both in Cordova and Baghdad, at Cairo and Fez for the education of pupils, where discourses were delivered by the most learned in the science."[2]

Ibn Baytar died in 1248 A.D. at Damascus and was known to Latin Europe as Aben-Bethar.

Khalifa Ibn Abi al-Mahasin of Halab

Khalifa Mahasin was the most distinguished and brilliant physician who had left an enduring impression on the world of thought. He is the author of a well-known treatise *Al-Kafi fil Kuhl* (1250 A.D.) which deals very elaborately with the diseases of the eye. The first part of this book deals with the anatomy of the eye and the second with its hygiene.

1. History of the Arabs, Hitti, p. 576.
2. Spirit of Islam, Ameer Ali, p. 387 and Ibn Abi-Usaybiah, Vol. II, p. 133.

This book also gives a detailed description of the instruments used in the surgery of the eye and synoptic tables relative to the diseases of the eye and the eyelids, giving for each disease the definition, description, varieties, causes, symptoms, treatment and drugs including narcotics. The book gives at the end a list of drugs.

Al-Mahasin was the topmost surgeon of the eye, who, according to George Sarton, was so sure of himself that he did not hesitate to operate on the eye of a man for cataract who had already lost the other eye.

The names of Abul Husain ibn Naffakh and Abul Khair cannot be left unmentioned as they were appointed Surgeons in the Baghdad hospital by the ruling sovereign, "Adud-ad-Dawla". They were famous surgeons and performed operations wonderfully. They also lectured on the art of surgery.

Ibn Al-Nafis

He was a remarkable figure among the Muslim physicians who wrote many things which were later attributed to European scientists. He wrote a treatise on the diseases of the eye.

Ibn al-Nafis (1210—1288), after completing his studies in Damascus, went to Egypt to head the famous and still extant, Mansuri Hospital of Cairo. There he wrote the famous commentary on Ibn Sina's *Qanun*, *Mujiz al-Haqa'iq* or *Mujiz fi al-Tibb*. In discussing the anatomy of the alveoli of the lungs and the heart, he presented, in opposition to the doctrines of Galen and Ibn Sina, a clear and exact explanation of the pulmonary blood flow. The greater and lesser circulation of the blood was presented later in the monumental and most noteworthy epochal monograph on the motion of the heart and blood entitled *Exercitatio Anatomica de Motu Cordis et Sanguinis* (1628) by William Harvey. Ibn Nafis is also considered by some scholars and scientists as one of the Chief fore-runners of Harvey.

Ibn al-Nafis explained clearly and systematically how the blood flows from the left half of the heart to the lungs through the pulmonary artery and, after it is aerated, returns to the left half of the heart by way of the pulmonary vein. He also denied the erroneous belief propagated by Galen and others of the existence of visible or invisible openings (pores) in the thick wall (the interventricular septum) between the two cavities of the heart.

His work earned a remarkable distinction in the Muslim world, including North Africa and Spain, and it is most likely that it reached the West and exercised its influence on the Spanish scholar, Michael Servetus (1511—1553), directly or indirectly, through the translation.

There were also two famous personalities, Abul Husain Naffakh and Abul Khair, who were appointed as surgeons in the Baghdad hospital by the ruling sovereign, Adud-ad-Dawla. They were famous surgeons and performed operations wonderfully. They also lectured on the art of surgery.[1]

"Knowledge of inoculation came originally from the Near East, where it had long been employed by the Muslims. Information concerning its use was relayed to England in 1717 through the letters of Lady Montagu, wife of the British Ambassador to Turkey. The first systematic application of the practice in the Western world, however, was due to the efforts of the great Puritan leaders, Cotton and Increase Mather, who implored the physicians of Boston to inoculate their patients in the hope of curbing an epidemic of smallpox which had broken out in 1721. By the middle of the 18th century inoculation was quite generally, employed by physicians of Europe and America."[2]

1. Al-Qifti, pp. 519 and 524.
2. E. M. Burns and P.L. Ralph, World Civilizations, p. 235, Oxford University Press, Pakistan, 1961.

Influence on Medicine

Muslim physicians, more particularly some of those who lived in Spain, contributed largely to the Renaissance in Europe. But in the matter of Muslim influence upon European medicine no names are greater than those of Al-Razi and Ibn Sina. Within a century and a half of the death of Ibn Sina, his works reached Spain and Sicily where they began to be translated. It was from these centres of learning that Arab science spread to other parts of Europe. The spread of Arab science in the West was mainly due to the fact that the Eastern Caliphs were in constant touch with the rulers of Europe. Harun al-Rashid sent an ambassador to the Court of the Roman Emperor. It is even said that Charlemagne came to Palestine *in cognito* in order to consult the Arab physicians about his health. The medical scholars of the Universities of Western Europe, like Montpellier and Bologna, particularly specialised in Arab learning and were responsible for the propagation of the teachings of Al-Razi and Ibn Sina. Montpellier had an immense library. All the translations made by Constantine the African and Gerard of Cremona were housed in this library at a time when the Paris University library hardly contained more than a score of medical works. From these centres the teachings of the Arabs spread to all medical schools in Europe. From the 12th to the 17th century Al-Razi and Ibn Sina were considered superior even to Hippocrates and Galen.[1]

1. Cyril Elgood, A Medieval History of Persia, p. 205; History of Muslim Philosophy, Vol. II, p. 1347; Amin A. Khairullah, Outline of Arab Contributions to Medicine and Allied Sciences (American Press, Beirut, 1946).

CHAPTER 9

Science of Chemistry

The Muslim contribution in the field of chemistry and physics is of far-reaching importance and has greatly influenced modern chemistry. Julius Ruska, a German scholar and an authority on the history of Muslim Science, rightly says: "Arabic Alchemy has developed so much and in so peculiar a way beyond that of the Greeks, and it had so exclusively influenced occidental alchemy that students of medieval sciences could not find a more attractive task than to trace the paths, until now mostly obscure which the development once followed."

Referring to the achievements of Muslim chemists, Joseph Hell says: "The oldest chemists, as a body, were alchemists. This notwithstanding, in their writings we find items of chemical knowledge which cannot be shown to have existed anterior to their times. They describe the methods of melting and solution, of filtering, crystallising, sublimating. They knew alum, salt petre, salammoniac, alkali prepared from tartar and saltpetre; and among them we first notice the knowledge of mineral acids. The increase in the number of artificially prepared substances; the perfection of methods handed down from the Greeks; the application of these methods to most diverse materials are the striking achievements of the Arabs in the domain of chemistry. If, in this direction, they advanced considerably beyond the Greeks, it was due to the fact that in place of hazy, mystical speculations they introduced objective experiments for the study of nature."[1]

1. Arab Civilisation, p. 100.

Among the Muslim scientists that might be mentioned as cultivators of alchemy, the naems of Jabir Ibn Hayyan, Al Razi, Abid, Umail, Tughrai, the author of a poem on alchemy, and Jildaki stand out prominent.

Jabir Ibn Hayyan

Jabir, well-known as Geber in the early Latin translations, is the father of Arabic alchemy, and flourished in Kufah about 776 A.D. He acted on the assumption that base metals such as tin, lead, iron and copper could be transmuted into gold or silver by means of a mysterious substance. He emphasised the importance of experimentation and made a distinctive advance in theory and practice of chemistry. He described scientifically the two important chemical operations of calcination and reduction. He improved on the methods of evaporation, filtration, sublimation, melting, distillation and crystallisation. He described the preparation of many chemical substances, e.g. cinnabar, sulphide of mercury, arsenics, oxides and others. He knew how to obtain nearly pure vitriols, alums, alkalis, sal-ammoniac and saltpetre, how to produce the so-called liver and milk of sulphur by heating sulphur with alkali. He prepared pure mercury oxide and sublimate, as well as acetates of lead and other metals. He understood the preparation of crude sulphuric and nitric acids as well as their mixture, aqua regia, and the solubility of gold and silver in this acid. Thus it was Jabir who acquainted Europe with the alchemy of the Orient and was the forerunner of modern chemistry. Jabir was also an able theoretician. In his treatises we find remarkably sound views on methods of chemical research, a theory on the geological formation of metals, the sulphur-mercury theory of metals, preparation of basic lead carbonate, arsenic and antimony from their sulphides. Jabir deals with various applications i.e., refinement of metals, preparation of steel, dyeing of cloth and leather, manufacture of varnishes and water-proof

cloth to protect iron, use of manganese dioxide in glass making, use of pyrites for writing in gold and distillation of vinegar to concentrated acetic acid.[1] He observed the imponderability of magnetic force. George Sarton has rightly remarked that, "he appears already as a very great personality, one of the greatest in medical science".

The writings of Jabir on alchemy were translated into Latin during the Middle Ages. The first version, the Book of the Composition of alchemy, was brought out by Robert of Chester in 1144 A.D. The translation of the "Book of the Seventy" into Latin was one of the achievements of the famous Gerard of Cremona. A work entitled "the Sum of Perfection" is ascribed to Jabir by the English translator Richard Russell (1678) who described him as Geber, the most famous Arabian Prince and Philosopher.

A deep study of some of the works of Jabir proves that he recognised more clearly and stated more definitely the importance of experiment than any other early chemist. Thus he was able to make great advances in both the theory and practice of the subject. According to Max Meyerhoff his influence could be traced throughout the whole historic course of European alchemy and chemistry.

Al-Razi

After Jabir Ibn Hayyan the study of alchemy was prosecuted further early in the ninth century with vigour by Muslim scientists, particularly in Persia, Egypt and Spain. The Persian physician Al-Razi (Rhazes) is of exceptional importance in the history of chemistry for he has left a lucid and systematic classification of chemical substances. Although dependent partly on the same sources as Jabir, Al-Razi excels him in his clear description of chemical process and

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apparatus. While other chemists divide mineral substances into bodies", "souls" and "spirits", Al-Razi classifies chemical substances as vegetable, animal or mineral, a concept which comes from him in modern speech.[1] The importance of Al-Razi's chemical work has been brought to light only very recently. His great book, "Book of the Art" on chemistry has been recently discovered. He was the first to introduce chemical preparation into the practice of medicine. His scheme of classification of the substances used in chemistry shows a sound chemical insight. It is as follows:

CHEMICAL SUBSTANCES

Mineral	Vegetable (rarely used)	Animal	Derivative
		Hair	Litharge
		Skull	Red lead
		Brains	(Tin oxide)
		Bile	Verdigris
		Blood	Burnt Copper
		Milk	(Cu O)
		Urine	Tutia (Zn O)
		Eggs	Rust of Iron
		Mother of Pearl	Smithy scales (F_3O_4)
		Horn	Cinnabar
			White arsenic
			Glass-dross (CaSie3)
			Caustic soda etc.

Spirits	Bodies,	Stones	Vitriols	Boraces	Salts
e.g.	*i.n.*	e.g.	Green	Natron	Sweet
Mercury	Metals	Pyrites	White	Borax	Bitter
Orpiment		Azurite	Yellow	etc.	Rock
Salammoniac		Malachite	Red		Qali
Sulphur		Haematite	etc.		Slaked
		Mica			lime
		Gypsum etc.			etc.

Razi gives also a list of the apparatus used in chemistry. This consists of two classes—instruments

1. Browne, E. G., Arabian Medicine, Ranking, G. S. A. Proceedings of International Congress Medicine, 1913, pp. 246—268; G. Sarton, Vol. I, p. 609; Islamic Culture, Vol. XV, p. 45 (1941).

used for melting metals, and those used for the manipulation of substances generally. In the first class were included a blacksmith's hearth, crucible, descensory, tongs, and a semi-cylindrical iron mould, while the second class included:

Cucurbite	Water-bath
Alembic	Large oven
Receiving flask	Hair-cloth
Aludel	Filter of linen
Beakers	Cylindrical stove
Glass Cups	Potter's kiln
Shallow iron pan	Chafing-dish
Sieve	Mortar
Heating-lamps	Flat stone mortar
Flasks	Stone roller
Phials	Round Mould
Cauldron	Glass funnel
Sand-bath	Dish

It will be observed that the list was comprehensive, but Razi completes the subject by giving details of making composite pieces of apparatus, and in general provides the same kind of information as found nowadays in the laboratory manuals.

Like Geber, Razi was a firm believer in the possibility of transmutation, and Stapleton describes his scheme of procedure approximately as follows. The first stage consisted in the cleansing and purification of the substances employed, by means of distillation, calcination, amalgamation, sublimation and other

processes. Having freed the crude materials from their impurities, the next step was to reduce them to an easily fusible condition. This was done by an operation known as ceration, which resulted in a product which readily melted, without any evolution of fumes, when dropped upon a heated metal plate.

From a general study of his chemical works, Stapleton says that henceforward Rhazes must be accepted as one of the most remarkable seekers after knowledge that the world has ever seen—not only "unique in his age and unequalled in his time", but without a peer until modern science began to dawn in Europe with Galileo and Robert Boyle.[1] The evidence of his passion for objective truth that is furnished by his chemical writings, as well as the genius shown by the wide range of books he wrote on other subjects, force us to the conclusion that with the possible exception of his acknowledged master, Geber, Razi was the most noteworthy intellectual follower of the Greek philosophers of the seventh to fourth centuries B.C. that mankind produced for 1,900 years after the death of Aristotle. "His supreme merit lay in his rejection of magical and astrological practices, and adherence to nothing that could not be proved, by experiment and test, to be actual fa t."

Later Muslim chemists, Ibn Umail, Al-Tughrai and Abul Qasim of Iraq, made some progress and wrote several books on chemistry. They gave to the West several chemical terms which have passed from Jabir's Arabic writings through Latin into European languages and are generally used in modern chemistry with great advantage. Their Arabic origin is recognisable, *prima facie*, in their Latinised form. Among these are: Alembic, Alkali, Alum, Aludel, Athomor, Azymum, Cinnabar, Elixir, Tutia, Usefur, Ziniar,

1. Stapleton, H.E., Journal of the Asiatic Society of Bengal, 1927, VIII, No. 6, pp. 317—418.

alcohol and a host of others.[1] In the history of chemistry Lavoisier is credited as being the founder of this science, but according to Dr. Le Bon it must be remembered that no science either of chemistry or any other science sprang up all of a sudden. It is the result of gradual evolution and development. There is no denying the fact that the Arabs had established 1,000 years ago their laboratories in which they made experiments and published the results of their researches and discoveries, without which Lavoisier would not have been able to produce anything in this field.

1. Ibn Khallikan, Vol. III, pp. 311-314; Al-Fihrist, pp. 299—302.

CHAPTER 10

Science of Geology

The contribution of the Muslims to the science of geology has been very significant. The Muslim scientists carried out extensive research in this field and developed their own theories which reached Europe through the Latin translations of their works and influenced the thinking of the scholars in the West.

Jabir Ibn Hayyan

The name of Jabir Ibn Hayyan stands out prominent among the Muslim scientists. He was the first scientist to synthesize minerals from natural ingredients. His account of the synthesis of cinnabar from mercury and sulphur is a piece of accurate experimentation and description.

Prior to his scientific research, minerals used to be grouped with rocks and fossils under the terminology and classification of "fossils". To Jabir goes the credit of dividing the minerals into three groups:

a) Spirits or substances that sublime, such as sulphur and orpiment, etc.

b) Metals or fusible substances that are malleable and have lustre, such as gold, silver, tin, copper and iron, etc.

c) Substances that can be powdered and are not malleable.

These substances were further classified into three categories:

a) Stony

b) Pulverisable or not

c) Fusible or not

This was no doubt an ingenious endeavour to classify minerals on the basis of their physical properties considering the environment of chemical knowledge and atomic structure during the time of Jabir Ibn Hayyan.

Al-Razi was the next great Muslim scientist who utilised minerals in his researches; and his stores contained pyrite, malachite, gypsum, haematite, galena, stibnite, cinnabar, turquoise etc.

Ibn Sina

The brightest luminary in this field was Ibn Sina whose theories were far ahead of his time. In his encyclopaediac work, *Kitab al-Shifa* he discusses a number of geological problems in detail which reveal his versatility of mind and modernity in thought and ideas. In his lengthy dissertation on the "Origin of Mountains", he has scientifically discussed the problem and developed a theory of three stages in this respect:

a) Condition of the formation of stones.

b) Condition of the formation of stones great in bulk or in number.

c) Condition of the formation of ridges and heights.

"He thought that pure earth (soil) could not petrify due to its crumbliness. It changes to stones through hardening of clay and by the congealation of water. The petrification itself may be triggered by earthquakes and subsidence of the soil. These ideas present a fair nearness to some of the modern views on rock genesis and as far as the importance of these factors in mountain building is concerned. About heights achieved by the mountains and the prevalence in them of ridges he cites two agents, earthquakes are responsible for the former and running water for the latter as it produces valleys and leaves ridges. It is a univers-

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ally recognised fact that the epicentres of all the major earthquakes are located in mountain belts; in fact, the earthquake activity in a mountain region may be related directly to the orogenic activity.[1]

Ibn Sina was the first scientist to point out that the mountainous regions were previously oceanic areas as was evidenced by the presence in stones of shells of acquatic animals (fossils); and prior to this fossils were believed to be animals that petrified on the surface of the earth.

"He also was concerned with the question of stones and ingeniously he related it to the abundance of clay in oceans. He also made a very close examination of the strata in mountainous regions and declared that strata had piled layer by layer; this is the modern theory of lamination in sediments. He also noticed that the partition between various layers was formed by substance of different nature so that the layers break after petrification. It is certain that in such observations he was concerned with what are now called the metasedimentary rocks that develop planes of easy splitting (schistosty) after having undergone metamorphism (Ibn Sina's petrification). In the same context, he discussed the problem of origin of clay in the oceans and declared that there were two sources for this material. Firstly, the sediments formed by the disintegration of mountains by water and wind and secondly, primeval matter. Although he did not elaborate the latter very much but it shows that he knew about the presence in mountains of rocks other than sedimentary; such rocks are now known as igneous and meta-igneous rocks. It is well-known at present that lava flows take place over the ocean floors and that certain rock bodies, originating from depths, intrude forcefully into the upper levels of the earth crust. Furthermore he must have noticed that laminated

1. Early Muslim Contributions to Geology by Dr. F. A. Shams, *Pakistan Times*, Lahore, October 18, 1968.

or stratified rocks themselves rested on structureless older rocks that might be another class of his primeval matter."[1]

In *Kitab al-Shifa*, Ibn Sina has devoted a chapter on mineralogy (Latin translation "*Liber de Mineralibus*", wrongly ascribed to Aristotle), in which he has denounced the theories held by his contemporaries that metals could be transmuted. He propounded the theory that "one metal cannot be converted into another unless its structure is broken and converted into the composition of that into which its transformation is desired". His researches and propositions were ahead of his time and he did not agree with the alchemists who thought that all the baser metals could be changed into gold.

For 23 years Ibn Sina made close observations of a certain part of the bank of the Oxus in an endeavour to discover the factors responsible for the formation of rocks. He at last arrived at the conclusion that soft clay changes into soft stone. He also found out that water dripping from caverns congealed into stone. His theory about meteoritic stones was a great improvement over Aristotle's views that such stones originated on earth, were blown to the heavens by wind and later on fell on the surface of the earth. Ibn Sina's advanced theory was that they originated in the heavens and fell on the earth.

Al-Khazini

Another outstanding scientist who made a significant contribution to the study of mineralogy was Al-Khazini Abd al-Rahman al-Mansur of Merv. During his measurements of specific gravities of natural substances he also included a few minerals. In his scientific work, *Al-Kitab Mizan al-Hikma* (1121-1122), he lists these measurements as follows:—

Gold	19.05
Emerald	2.77

1. *Pakistan Times*, Lahore, October 18, 1968.

Pearl	2.60
Mercury	13.56
Brass	8.57
Ivory	1.64
Sweet water	1.00
Boiling water	0.958
Olive Oil	0.920

These figures are mostly acceptable in modern terminology. He took all the precautions against the effects of temperature variations, purity of water etc.

Dr. Imamuddin rightly thinks that Muslims also studied geology. Ibn Sina and Umar Khayyam were great geologists of the Arab world. The Spanish scholars wrote works on the formation and classification of minerals, the stratification of rocks and the subsidence of the crust in different Ages.[1]

Al-Tifashi

Max Meyerhof is of opinion that "Mineralogy stood in close relation to alchemy." Nearly 50 Arabic lapidaries have been named, and the best known of them is the "Flowers of Knowledge of Stones", by Shihab al-Din al-Tifashi (d in Cairo A.D. 1154). It gives in 25 chapters extensive information on the subject of the same number of precious stones, their origin, geography, examination, purity, price application for medicinal and magical purposes, and so on. Except for Pliny and the spurious Aristotelian lapidory, he quotes only Arabic authors.[2]

1. Dr. S.M. Imamuddin. Some Aspects of Socio-Economic and Cultural History of Muslim Spain, p. 159 (Leiden, E.J. Brill, 1965)
2 The Legacy of Islam, p. 341.

CHAPTER 11

Science of Geography

In the field of geography too, the Muslims made a great headway. During Caliph Al-Mamun (813—833) the government appointed a committee under Mohammad ibn Musa Al-Khwarizmi to make a survey of the globe. Seventy great minds worked to explore the field and ultimately they were able to produce the first map of the globe in 830 A.D. This activity of the Arabs heralded the dawn of a new adventure in the rough seas.

Some of the outstanding Muslim geographers have referred to the hypothesis of the daily rotation of the earth. In this respect mention may be made of the book "*Kitab-i-Kalimat ul-'Ain*" in which discussions have been made on this theme. According to J.H. Kramers the geographical works of Muslim astronomers had left a far-reaching influence on the medieval science in Europe. The study of such scientific literature of the Arabs contributed "to the keeping alive of the doctrine of the sphericity of the earth."[1]

The researches of the Muslim scholars in this field brought home the idea that the known hemisphere of the world had a Caitre of "World Summit" situated at an equal distance from east, west, north and south". This idea gained ground into the later geographical literature of Europe, e.g., in the *Image Mundi of* Cardinal Peter of Ailly which was published in 1410 A.D., and it was from this book that Christopher Columbus learnt the same doctrine, which had in the

1. Legacy of Islam, p. 93.

meantime developed so far as to make Columbus believe that the earth was shaped in the form of a pear".[1]

Guided by these scientific data, Columbus was inspired to hazard out in the seas five centuries later, believing that the earth was a globe, and not a flat saucer. Thus in search of Indian condiments, Columbus, who had been taught this knowledge of geography by an Arab, discovered the American Continent.

The Muslim geographers were fully aware of the idea of the sphericity of the earth. They determined the size of the earth and its circumference basing their knowledge on the assumption that the earth in form was spherical.

Philip K. Hitti thinks that "the measurement, carried out on the plain north of the Euphrates and also in Palmyra yielded 56⅔ Arabic miles as the length of a degree of the meridian—remarkably accurate results".[2]

There is every reason to believe that Muslim scholars were conversant with the idea of the sphericity of the earth as the terrestrial globes were in common use in Muslim countries, and in Andalusia geography was taught in schools with the aid of these globes. Ameer Ali says that "at a time when Europe firmly believed in the flatness of the earth, and was ready to burn any foolhardy person who thought otherwise, the Arabs taught geography by globes."[3]

Navigation and Commerce

The Arabs made free use of the magnetic needle or Mariner's Compass and the stars to help them navigate their ships on the high seas. Some Western writers ascribe the invention of this instrument to the Chinese, but according to George Sarton, the first

1. Legacy of Islam, p. 94.
2. A short History of the Arabs, p. 112.
3. Spirit of Islam, p. 384.

practical use of the magnetic needle was credited by the Chinese themselves to foreigners, "who were in all probability Muslims".

There is no denying the fact that maritime trade between the Far East on the one hand, and India, Persia, Arabia and Africa on the other, was a Muslim monopoly.

Philip K. Hitti, is also of the opinion that "the Chinese were probably the first to discover the directive properties of the magnetic needle, but the Muslims, who very early carried lively trade between the Persian Gulf and Far Eastern waters, were the first to make practical use of the discovery by applying the needle to navigation. This practical use was made during the eleventh century A.D.

"When Vasco da Gama, after his circumnavigation of the African continent in 1498 A.D. had reached Malindi on the east coast of Africa, it was an Arab pilot, Ahmad Ibn Majid of Najd who showed him the way to India. According to Portuguese sources this pilot was in possession of a very good sea map (chart) and of other maritime instruments. The same pilot is also known as the writer of a sailing manual for the Indian Ocean, the Red Sea, the Persian Gulf, the South China Sea and the East Indian Archipelago."[1]

With the help of the compass the Muslims became the masters of rough seas and travelled to all parts of the world in their swift-sailing boats. Most of the seas were surveyed, maps were prepared, and guides compiled for the use of the sailors. Fleets were launched in the seas to establish trade and commercial links with the remotest corners of the world. Sidi Ali Ibn Husain, in his renowned treatise on oceanography, *Al Muhit* (1554 A.D.), has scientifically given detailed geographical and nautical description of the

1. Legacy of Islam, p. 96 and History of Mankind, Vol. IV, Part II, p. 824.

seas. "This is perhaps the only work of its kind which furnished information pertaining to the progress of Muslim oceanography made up to the end of the Middle Ages".

Allama Syed Sulaiman Nadvi, a great historian and scholar of Indo-Pakistan sub-continent in his book "Arabs' Navigation (*Arabon ki Jahazrani*) has given a list of 15 Arabic works of Ibn Majid on Navigation. One of these works, *Kitab al-Fawaid-fi Usul-al-Bahr-wal Qawaid*, "is a compendium of all the then known knowledge of theoretical and practical navigation, a synthesis of nautical science of the latter years of the Middle Ages." This book has also been edited by G. Ferrand in Paris in 1921-23.[1]

Maps

Most of the scholars of geography included maps in their works which reveal a tendency to represent the coast-line and the rivers under conventionalised forms. In this respect mention may be made of Al-Idrisi's maps which are significant on account of the fact that his text is mainly a commentary on them.

Al-Biruni in his *Kitab-al-Hind* which was completed in 1030 at Ghazni, has given a wonderful round map of the world. In *Athar al-Baqiya*, a scientific description has been given of some geometrical methods for the projection of maps of the sky and of the earth. Blochet published in his study of Muslim Cartography at Bonn in 1898 A.D. a treatise known as "*Contribution a L'etude de la Cartographie chez les Musalmans.*"

Al-Khwarizmi

During the early ninth century the Muslims assimilated the geographical knowledge of the Greeks and mastered Ptolemy's *Almagest*. This treatise was

1. Allama Nadvi's Arabon ki Jahazrani, 1 and Hitti's History of the Arabs, p. 689.

rendered into Arabic by three great scholars, Ibn Khurdadbaih, Al-Kindi and Thabit Ibn Qurrah.

Al-Khwarizmi made full use of the *Almagest* in his geographical work, *Kitab Surat ul-Ard*, a manuscript copy of which was preserved at Strassbourg. He improved Ptolemy's geography, both the text and the maps.[1]

Ibn Musa Al-Khwarizmi lived and flourished at Baghdad during the regin of Al-Mamun, under whose orders the measurement of a degree was carried out in the Syrian desert. Al-Khwarizmi also associated himself with this project with other great scholars. His geographical work had exercised a tremendous influence on the later thinkers in this field. The Strassbourg manuscript of *Kitab Surat ul-Ard* had been edited with an Italian translation by Nallino with a full investigation of the geographical data. The text of this work has also been edited by Hans V. Mzik and published in the *Bibliothek Arabischen Historiker* and *Geographen*.

Abu Zaid Al-Balkhi

Al-Balkhi is the author of 43 books. His most famous treatise is *Suwar ul-Aqalim* containing maps of different countries. This is now extant but a major portion of this book is incorporated in later treatises like those of Al-Istakhri and Ibn Hawqal. The elaborate work of Istakhri (flourished in 950 A.D.), *Masalik wal-Mamalik*, that has come down to us with coloured maps of countries and other details, is said to be based on it.[2] Frequent references to Balkhi's treatise have also been made by such well-known geographers as Muqaddasi and Hamdullah Mustawfi in their works.[3]

Ibn Hawqal

Abul Qasim Ibn Hawqal was a great traveller of the tenth century A.D. Leaving Baghdad in 943, he

1. George Sarton, Vol. I, p. 563; Al-Fihrist, p. 274.
2. History of the Arabs by Hitti, p. 385, and Dairah-al-Ma'arif Islamia.
3. Al-Fihrist, p. 138.

travelled extensively through the length and breadth of the Muslim world and after his return wrote *Kitab al-Masalik wal-Mamalik*, a book of great m rit. He met Al-Istakhri and on his advice made some alterations and amendments in his maps.

Al-Muqaddasi

Shamsuddin Abu Abdullah Al-Muqaddasi (d: 1000 A.D.) is reckoned as the scholar and author of the most original and valuable treatise in Arabic literature. He visited all the Islamic countries except Spain and Sijistan during a period of 20 years, and wrote in 985 A.D. an account of his experiences in his delightful book *Ahsan al-Taqasim fi Maarifat-al Aqalim.* It is verbose and replete with special idioms peculiar to every region that he visited. An English translation of his work was published in four parts by the Asiatic Society of Bengal from 1897 to 1910. J. Gildemeister has edited the chapter that deals with Syria and Palestine. A. Sprenger is of the opinion that Al-Muqaddasi is "the greatest geographer of all ages".

Al Mas'udi

Abdul Hasan Ali Ibn al-Husain Al-Mas'udi is regarded as one of the most versatile scholars and writers of the tenth century. He was born in Baghdad. C. Brockelmann says, "while still quite young he travelled through Persia where he spent part of 915 A.D. in Istakhar. Next year he went to India and visited Multan and al-Mansura. He went to Kambaya and Saimur as far as Ceylon, joined some merchants on a voyage to the China Sea and back to Zanzibar, from where he returned to Oman. We again find him travelling along the southern shore of the Caspian Sea and in 926 A.D. at Tiberius in Palestine. In 943, he visited Antioch and the Syrian frontier towns, and after a brief visit to his native place, Damascus, he died in Fustat in 956 A.D."[1] He is the first scholar to

1. Brockelmann, English translation J. Carmichael and M. Parlmann and Al-Fihrist, p. 145.

mention wind-mills in Sijistan and writes about Muslim traders actively engaged in business in Bohemia.

According to Brockelmann, Al-Masudi travelled extensively "stimulated not by thirst for adventure but by a strong desire for knowledge", and wrote two most outstanding books on geography, *Muraj-uz-Zahb* and *Kitab al-Tanbih wal-Ishraf.* The first book is remarkable because of the catholicity of its author, who neglected no source of information, and of his truly scientific curiosity[1]. An English translation of this work was published by Sprenger at London in 1842.

The second book *Kitab al-Tanbih* is an epitome of Masudi's life work. Carra de Vaux published a French translation of this book at Paris in 1896 and De Goeji has also worked on this publication and edited it as Volume VIII of the *Bibliotheca Geographorum Arabicorum.*

Ibn Fadlan

Ahmad Ibn Fadlan was also an eminent Muslim traveller and was accredited as an ambassador by Caliph Al-Muqtadir in 921 A.D. to the Court of King of Bulgarians, residing along the Volga[2]. His geographical treatise *Al-Risalah* gives a beautiful and an authentic account of Russia. According to W. Barthold this book seems to have been used as early as the 10th century by al-Istakhri and al-Masudi. Yaqut Hamawi has given extensive quotations in his work which has been of immense value to the later writers.[3]

Al-Biruni

Abu Raihan al-Biruni is considered as one of the versatile scholars of the Middle Ages. He was born in 973 A.D. and died in 1048. He possessed an ency-

1. Introduction to the History of Science, George Sarton, Vol. I, p. 638.
2. *Ibid.*, Vol. I, p. 636.
3. Ibn Abi Usaybiah, Vol. II, p. 52.

clopaedic mind and wrote on such varied subjects as mathematical geography, history, physics, astronomy and chemistry. His keen observations and sound grasp of events have made him excel in diverse fields of knowledge. His most renowned books are: *Al-Qanun al-Masudi* (*Canon Masudicus*) and *Kitabul Hind*. The former is a monument of research and learning on astronomy, and the latter is an exhaustive study of religion, philosophy, literature, geography, chronology, astronomy, customs, laws, manners and astrology of the Hindus.[1] An authentic translation of this book has been furnished to us by Dr. Edward Sachau in English.

Al-Biruni also carried out geodetic measurements and determined latitudes and longitudes with some accuracy. He measured the specific gravity of precious stones and explained natural springs and artesian wells on the principle of water finding its own level in communicating channels.[2]

Abu Ubaid Al-Bakri

Al-Bakri belonged to a noble family of Andalusia and completed his education in Cordova. He died in 1094 A.D.

He was an eminent geographer of the eleventh century and author of the well-known book, *Kitabul Masalik wal-Mamalik*, an epitome of the experiences gained by him during his travels.[3] Some portions of the book dealing with North Africa, Egypt and Spain are in existence. The African part of this book was edited by Baron de Slane Al-Algiers in 1857, of which an improved edition appeared in 1910. A Russian version of the portion of the book dealing with the Russians and the Slavs was published by Kunik and Rosen at St. Petersburg in 1878.

1. George Sarton, Vol. II, Part I, p. 410.
2. Dampier, A History of Science, p. 75.
3. Ibn Abi Usaybiah, Vol. II, p. 52.

Al-Idrisi

Abdullah Mohammad al-Idrisi was born in Ceuta in 1100 A.D. and received his education in Cordova under renowned professors and died in 1166 A.D. He occupied a high position in the Court of King Roger II of Sicily and compiled a geographical treatise known as *Nuzhat-al-Mushtaq fi Ikhtiraq al-Aflak* which was translated and published at Rome in 1619 A.D. The *Rujari* (Roger's Book) is the most elaborate description of the world of medieval times.[1]

Philip K. Hitti says: "He was the most distinguished geographer and cartographer of the Middle Ages. His Rogerian treatise not only sums up the main features of such preceding works as those of Ptolemy and Al-Masudi, but is primarily based upon original reports submitted by observers who had been sent to various lands to secure data. In his critical collation of the material Al-Idrisi shows a remarkable breadth of view and a grasp of such essential facts as the sphericity of the earth. He located the sources of the Nile supposedly discovered in the middle nineteenth century, in the equatorial high-lands of Africa. Besides this monumental work, Al-Idrisi constructed for his Norman patron a celestial sphere and a disk-shaped map of the world, both in silver".[2]

J. H. Kramers has rightly commented, "The fact that King Roger entrusted the composition of a description of the known world to a Muslim scholar indicates clearly how far the superiority of Muslim learning was acknowledged at that time."[3]

Al-Idrisi was invited to Palermo by Roger, King of Sicily, and there he composed a book on geography. In vividness of description, in accuracy of detail, in correct estimation of distances, it is one of the most remarkable literary productions of medieval times.

1. George Sarton, Vol. II, Part I, p. 410.
2. A short History of the Arabs, p. 158.
3. Legacy of Islam, p. 89.

The incomplete work of Ptolemy had been the recognised authority. The configuration of the earth's surface, its climates, the locations of continents and seas, of cities and empires, were facts little known, even to persons of best education. The compilation of Al-Idrisi marks an era in the history of the science.

For three centuries geographers copied his maps without alterations. The relative position of the lakes which form the Nile, as delineated in his work, does not differ greatly from that established by Baker and Stanley more than 700 years afterwards and their number is the same. The celestial and terrestrial plain sphere of silver which he constructed for his royal patron was nearly six feet in diameter, and weighed 450 pounds; upon one side the zodiac and the constellations and upon the other, the bodies of land and water, with the respective situation of the various countries, were engraved.

Yaqut Al-Hamawi

One of the most comprehensive writers of geography during the closing years of the Abbasid period was Yaqut al-Hamawi, born in 1179 A.D. and died in 1229 A.D. He was a Greek boy purchased by a merchant of Hamah and given highest education. For a number of years he accompanied his master as a commercial clerk and was later enfranchised. He then took to copying and selling manuscripts and travelled extensively in the pursuit of this profession, collecting valuable material for his encyclopaedic geographical dictionary, *Mu'jam al-Buldan*, commenced at Mawsil in 1224 A.D. and completed at Halab in 1228 A.D. It is a veritable treasure of geographical knowledge of the time containing valuable information on ethnography and natural sciences as well. It describes all kinds of geographical names in alphabetical order.[1] The book was edited and published in six volumes at Leipzig during the years 1666—1673 A.D.

1. Ibn Khallikan, Vol. IV, pp. 9—23.

The work is biographical and the author's main ideal is to explain the surnames of well-known people, named after their birth places and the places where they lived.

George Sarton with critical appreciation remarks, "the *Mu'jam al-Baldan* is one of the most important works of Arabic literature. It is a store-house of information not simply on geography, but also on history, ethnography and natural history. It is preceded by an introduction dealing with mathematical, physical and political geography, the size of the earth, the seven climates etc."[1]

Al-Qazwini

Abu Yahya Zakariya Ibn Mohammad Al-Qazwini was born in 1203 and died in 1283. He met the great philosopher Ibn al-Arabi and was appointed *Qazi* of Wasit by the Caliph Al-Musta'sim. His fame rests on his well-known geographical treatise *Ajaib al-Makhluqat wal-Ghraib-al-Maujudat* which is valued as the first systematic cosmographical work in the world of Islam. It is divided into two parts dealing respectively with celestial things (planets, stars, angels, chronology) and with terrestrial ones (four elements, minerals, plants, animals, man). This latter part also contains much geographical material which is repeated (often verbatim) in the Geography.[2]

A. Struck rightly thinks that "It must be deemed a work of fundamental importance and is the most valuable book that Arab Middle Ages have given us in this field." It was translated into various European languages besides Persian and Turkish. A German translation of the first half of this book was published at Leipzig in 1868 by Hermann Ethe.

Another remarkable treatise of Al-Qazwini is *Athar al-Bilad Wa-Akhbar al-Ibad* in which he has

1. George Sarton, Vol. II, Part II, p. 642.
2. G. Sarton, Vol. II, Part II, pp. 868-69.

given a description of the earth, following the Ptolemaic division into seven climes or longitudinal zones. Within each clime separate countries, towns, mountains, islands, lakes, rivers, etc., are arranged in alphabetical order, their remarkable features are described and many historical events connected with them are given. A major portion of this book covers the biographies of eminent personalities.

Hamidullah Mastawfi

Mastawfi's geographical treatise, *Nuzhat al-Qulub* is of great value as G. Le Strange has extensively referred to this book in his admirable work, Lands of the Eastern Caliphate.

In his introduction to the book, Mastawfi has dealt with cosmography; in later chapters the topics covered are: natural history, anthropology and geography and the wonders of the world (especially of Persia). Le Strange has edited and translated the geographical portions of Nuzhat in English.

Ibn Jubair

Ibn Jubair (Abu Al-Husain Mohammad Ibn Ahmad) also travelled extensively and compiled the results of his observations and experiences in the well-known book *Rihlat al-Kinani*. Being one of the most important works in Arabic literature, it was published at Leiden in 1852 A.D. This book gives an insight into the conditions obtained in Sicily under King William II from 1166 to 1189.

Ibn Battutah

Abu 'Abdullah Mohammad Ibn Battutah (1304-1377 A.D.) born in Tangiers, was in some ways the most astonishing globe-trotter. He travelled extensively in Africa, Bokhara, Afghanistan and India. At Delhi he was appointed to the position of a judge by Sultan Mohammad Tughlaq and left with the official delegation to China, but on his way he broke his journey at

Maldive Islands and remained there for one and a half years. From there he travelled to Ceylon, Bengal and Assam and arrived in China. He also visited Persia, Morocco and Spain. Altogether he covered about 75,000 miles and wrote of his experiences with interest and urbanity, giving information about peoples unfamiliar even to the Muslims of the time.[1] His book of travels *Tuhfat-al-Nazzar fi Ghraibul Amsar wa-Ajaebul Asfar* is still a mine of information and has been translated in different languages of the world. It was rendered into English by Rev. S. Lee, B.D., London, 1829.[2]

Ameer Ali thinks that "Ibn Battutah visited foreign lands in quest of information, and wrote voluminous works on the people of those countries, on their fauna and flora, their mineral products, their climatic and physical features, with astonishing perspicacity and keenness of observation."[3]

Estimating the achievements of the Muslims in the science of geography S.P. Scott writes, "The Moorish scholars of Spain made invaluable contributions to the general stock of geographical knowledge. Abul Fida enumerates sixty Arabic geographers who lived before the thirteenth century. Many of their maps were veritable works of art, in which, upon a ground of silk, continents, mountains, lakes and streams represented in relief, were embroidered in gold and silver. Ibn Hamid penetrated to the most inaccessible regions of Central Asia. Ibn Jubair visited and described Sicily and the countries of the orient. Abu Obaid al-Bakri was the author of a geographical dictionary in which were described an immense number of cities, principalities and kingdoms".

1. History of Mankind, Vol. IV, Part II, p. 818.
2. Dairatul Ma'arif Islamia, Encyclopaedia Britannica, Vol. XII p. 33, and Oriental Biographical Dictionary, T. W. Beale, 1965 p. 167.
3. Spirit of Islam, p. 393.

Influence on Geography

Historical evidence proves beyond doubt that the geographical knowledge and research of the Muslims exercised a considerable influence on Europe. During the eleventh century a more congenial environment existed in the Islamic world for the scientific study of this subject than in the Latin world. C.R. Beazley thinks that "It was only Jewish thought which was moving forward due to direct contact with Muslim culture and under the stimulus of its progressive impulses.

"Pedro Alfonso made a sketch-map of the world clearly derived from Muslim models, copying the seven climates and putting south on the top. Henry of Mayence compiled a treatise in 1110 which included a map. A geographic encyclopaedia was prepared in 1119 by Guido who was probably an Italian geographer. Lambert of Saint Omer compiled another encyclopaedia with maps; in this work he propounded his belief in the sphericity of the earth. Herman the Dalmatian in 1143 prepared his cosmographical compilation, which included astronomical and geographical information, and Bernard Sylvester produced his *De Mundi*.

"Nearly all the above named writers and their contemporaries who deal with geographical matters were steeped in patristic and Latin traditions. But by the middle of the thirteenth century, a distinct change was perceptible, as by that time the full impact of the translations was evident in the more readily available Arab knowledge in Europe. Scholars were not only aware of it, but were beginning to feel the need of it. The new knowledge, of which Muslim geographical information and notions were an indispensable part, began to work as a great stimulus to new ideas in the Latin world.

"Henceforward the level of geographic thinking and writings was definitely raised. Vincent of Beauvais, Albert the great, Roger Bacon, and others were

all sufficiently influenced by Arab Knowledge of geography and its associated fields.[1]

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There is no doubt, "gradually most of the basic and current geographical ideas of the Muslims were passed on to the West. These were with regard to the size of the earth and its sphericity, oceans, geological processes, climate, vegetational and zoological distributions, knowledge of new lands in Africa, Far East and Central Asia, techniques of cartography and uses of instruments.[3]

"All this knowledge in various degrees of assimilation is depicted in the leading geographical works and forms the background of the so-called *mappae mundi*,

1. C. R. Beazley, The Dawn of Modern Geography, Vol. II, p. 8 (London and Oxford).
2. Roger Bacon, *Opus Majus*, Vol. I, p. 318.
3. G. Ferrand, *Introduction a l'astronomie nautique Arabe*, p. 225 (Paris, 1928).

and also in some of the maps of later generations preceding the Columbian era, *viz.*, Psalter map (1200), Hereferd map (1280), the world map of Marino Sanuto (1321), the Borgian world map (1450), Este world map (1450)[1] Fra Mauro's Africa (1459), and the diagrams of *L'image du Monde* (1480).

"Though these maps were far from being real maps and mirrored more the shadows of patristic and traditional notions, yet acquaintance with Arab cartography and geographic information is revealed in them".[2]

1. G. H. T. Kimble, Geography in the Middle Ages, p. 197 (Methuen, London, 1938).
2. J. Keane, The Evolution of Geography, p. 48 (Edward Stanford, London, 1899) and History of Muslim Philosophy, Vol II, pp. 1272-1274.

CHAPTER 12

Inventions and Mechanical Contrivances

There is no denying the fact that for nearly ten centuries Muslims held aloft the torch of knowledge and learning; art, literature, philosophy and science prospered to their highest degree; and there is no branch of human civilisation on which they did not leave their indelible mark. Civilisation is a continuous process of human endeavour, experience, deep and original thinking; and our modern progress is no doubt the result of the past contributions of intellectual scientific giants.

Starting with the treasuries of Greek masters the Muslims built up a magnificent edifice of research, inquiry and scientific observation of nature and bequeathed a remarkable and glorious legacy of an enlightened race. With their accomplishments in experimental methods and observations they surpassed their masters, and in the fields of mathematics, astronomy, chemistry, physics, medical sciences, biology and geology made some of the most outstanding and original contributions, discoveries and inventions which paved the way for modern scientific and technological progress.

Magnetic Needle

Europe owes to Muslims the adaptation of the magnetic needle for the purpose of navigation. Originally inserted in a cork and permitted to float on the surface of water, the Muslims were the first to mount it on a pivot, thereby considerably increasing its utility

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Magnetic Needle

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and accuracy. They possessed its working knowledge before the 12th century. The magnet possessed a threefold significance and value. It guided their vessels across the vast seas and oceans independently of the appearance of the stars. It indicated with great exactness the course of the caravan in the limitless desert and also enabled the worshippers, however distant from the holy Ka'aba, to determine in no time the direction they should face during prayers.

J. H. Kramers thinks that "It is safer to assume that, even if the Muhammadans knew of the compass earlier than European Christians, their acquaintance with it does not go back beyond 1200 and that, soon after it became known to them, the knowledge of it was passed on to Christian navigators."[1]

Clocks

With their expertise in applied mechanics and engineering talents, the Arabs made accurate devices for measuring time, clepsydras or water-clocks. The earliest reference to a clock is found in Al-Jahiz's *Kitab al-Haywan*[2] in the second half of the ninth century.

Between 1146 and 1169 Mohammad ibn Ali ibn Rustam of Khorasan, known as *al-Sa'ati* "the Horologist", constructed the clock which was placed on the *Bab al-Jayrun* of Damascus. Mohammad Ibn Ali remained incharge of the clock till his death in 1184 or 1185. Ibn Jubair, the Arab traveller, who was in Damascus in 1173, gives a report of the clock which shows that he saw it in its original form. It was seen and mentioned by Qazwini and Ibn Battutah as well. Benjamin of Tudela, who travelled between 1159 and 1173 also gives a brief description of the clock. Mohammad ibn Ali's son Fakhruddin Rizwan repaired and improved this clock and in 1203 wrote

1. Legacy of Islam, p. 98.
2. G. Sarton, Vol. II, p. 632.

a book on astronomical clocks which contains a number of drawings, illustrating the mechanism and functioning of the clocks.[1]

Rizwan was born in Damascus and entered the service of Ayyubid ruler Al-Malik al-'Adil Nuruddin Mahmud ibn Zangi (1146-1174) who treated him with great munificence and appointed him as officer-in-charge of the construction of clocks. His two sons were, like himself, known as *Ibnus Sa'ati*, but neither of them had taken up the profession of the father; the one being a prominent poet of his age and the other a distinguished physician and *litterateur* who used to be a *vazir* (minister) to al-Malikul Faiz and to his brother al-Malikul Muazzam ibn al-Malikil 'Adil, and at the same time served as physician to Muazzam.[2]

The fact that a number of men were called *Sa'atis* is in itself a testimony of there being men who were clock-makers by profession. Besides this family of *Sa'atis* there were also other *Sa'atis*. Haji Khalifa mentions one Mohyuddin Abul Ma'ali Murtafi ibn Hasan *as Sa'ati*.[3]

Badiuz-Zaman Abu Bakr al-Mu'izz ibn Ismail, ibnur Razzaz al-Jazari composed his excellent work, *Kitab al-Banakim*, in 1206 in Mesopotamia, on water-clocks, magic-cups and all kinds of hydraulic apparatus.[4]

During the twelfth and thirteenth centuries clocks, sun-dials and similar instruments of much developed type with elaborate mechanism were in common use.

1. M.S. in Gotha (Germany), No. 1348 of Pertsch's Catalogue, Vol. III, p. 18 and Wiedemann.
2. Ibn Usaybiah, edited by Mueller (Koenigsberg 1884), Vol. II, p. 183; Wiedemann, Beitraege, III, pp. 231-232.
3. *Kashfuz-Zunun*, edited by G. Fluegel (Leipzig), Vol. I, 346; Vol. II, p. 1171.
4. MSS in British Museum (No. 1661) and in the *Bibliotheque Nationale*, Paris (No. 2477).

Abul 'Abbas Ahmad ibn Umar as-Sufi, an eminent astronomer, wrote a treatise on how to "remove the defects in the construction of a sun-dial". Gnomonic instruments served an important purpose for the Muslims as it was imperative for them to know the exact hours of the five daily prayers. The Muslim scientists, therefore, worked on their improvement with great devotion and developed such devices as the sand-glass, the candle-clock and the mercury clock.

Besides, the Muslim scientists began to construct mechanical clocks. A treatise on the technique of this type of clocks is preserved in two manuscripts in Oxford and Paris.[1] Taqiuddin Abu Bakr Mohammad ibn Maruf ar-Rasid *i.e.* "The Observer" (1525-1585) wrote his book in Constantinople during the reign of Sultan Sulaiman (1520-1566), who was very fond of beautiful clocks. He constructed clocks with wheel-work (*as Sa'atud-Dawriya*). These worked by a number of wheels and wound by drawing a chain with a weight attached to its lower end.

S. P. Scott writes: "They made use of clocks moved by water, sand and weights. The oscillatory property of suspended bodies, represented by the isochronous of the pendulum, was familiar to the Arabs who had adopted it to a contrivance whose construction resembled that of the modern clock."[2]

Max Meyerhof believes that water-clocks were frequently constructed in the Islamic countries. One specimen was presented to Charlemagne (in 807) by an envoy sent by Harun-al-Rashid.[3]

Gunpowder and Artillery

The scholarly research and investigations of Reinand, Le Bon, Viardot and others have revealed

1. Brockelmann, *Geschichte der arabischen Literatur*, Vol. I, p. 495.
2. History of the Moorish Empire in Europe, Vol. 3, Chapter XXX
3. Legacy of Islam, p. 333.

that the Arabs were inventors of gunpowder and artillery. As a matter of fact, these were first made use of in Syria and Egypt in the thirteenth century. Artillery was employed by the Moors when they were besieged in Nieble by Alfonso X in 1257. According to Ibn Khaldun, it was used by Abu Yusuf, Amir of Morocco, at the siege of Sidjilmesa, in 1273. Ibn Khatib says that cannons were made in Granada before 1300 and mentions Ibn-al-Hadj as famous for his skill in their manufacture.[1] According to an article in the Encyclopaedia Britannica, the "Arabs used rockets on the Iberian peninsula in 1249; and in 1288 Valenica was attacked with rockets.[2]

Ibn Baytar, (d. 1248) Abu Mohmmad Abdullah bin Ahmad al-Maliqi, who was a resident of Malaga, compiled a book in which he gave a formula for making gun powder. This book was written just eight years after the defenders of Pien-King (1232) used their flying arrows to defend their city against the Mongol attack led by Ogadai, third son of Chengez Khan. These flying arrows filled with gun powder exploded on landing with noise and violence. He named this mixture of salt petre, coal and sulphur—*bārood*.

The Astrolabe

"Amongst the things brought back by wandering scholars who sought in Muslim seats of learning knowledge unknown in their own countries, the astrolabe was a most important acquisition. An astronomical instrument of ancient Greek invention, improved by the Alexandrian geographer Ptolemy, and perfected by the Muslims, the astrolabe came to Europe some time in the tenth century. Its principal use in the East was to determine the hour of prayer and the position of Mecca.

1. S.P. Scott, History of the Moorish Empire in Europe, Chapter XXX, Vol. 3.
2. Vol. 19, p. 366, London, 1960.

The earliest dated astrolabe known is at Oxford. Made in 984, it was the joint work of two masters, Ahmad and Mahmud, sons of Ibrahim, the astrolabist of Ispahan."[1]

Scott writes: "The Arabic armillary spheres and astrolabes preserved in the museums of Europe are not surpassed by the most laborious efforts of modern ingenuity in excellence of finish and in the accuracy of adjustment."

The modern almanac is also their invention.[2]

Rocket

The first landing of man on the moon (July 24, 1969) and the probe by an unmanned spacecraft of the planet Mars, all these, and more to come are due to the development of rocketry. In modern times the use of long-range rockets began with V-1 and V-2 of Hitler which were fired from Europe on England. But rocketry as such is the Muslim invention.

"The rocket is not a European invention. Its idea was brought to Europe by the Arabs", writes, Willy Levy, in his book "Rockets, Missiles and Space Travel". In it he has devoted six pages to the contribution of the Oriental people to the art of rocketry.

Najmuddin Hassan al Rammah, a Syrian, wrote a book on military science in 1280 called *al-Furusiyah wal-Manasib al-Harbiyah*, (The Book of Fighting on Horse-back and with War Engines). It gives a formula for making dry fuel for rockets as well as the directions for making them.

Hassan al-Rammah thinks that the Chinese made a mixture of salt-petre, sulphur and charcoal which they filled in the "flying arrows" they used against the

1. Legacy of Islam, pp. 114-115.
2 S. P. Scott, Vol. 3, Chapter XXVIII.

Mongol invaders directed from the walls of the city of Pien-king in 1232.

What Hassan al-Rammah wanted to construct was not a flying carpet or a flying horse but a rocket that was powerful enough to lift a man into space. In his book he gives an original rocket-propelled torpedo consisting of pans, filled with powder and equipped with a tail to ensure its movement in a straight direction. It was propelled by two large rockets on the side of this oval shaped device. He named it "The Self Moving and Combusting Egg"; as the one rocket gave out flame the other caused a forward movement. The jet engine works on the same principle as the rocket. A rocket carries the oxygen needed for combustion along with it, while a jet mixes the oxygen in the air with the fuel it carries.[1]

Today many engineers are using liquid-fuel to put their rockets into space. Dr. Robert Goddard, the American rocket expert, developed a simple liquid motor in 1920-22. This rocket motor, like that of Hassan al-Rammah, had an egg-shaped combustion chamber with fuel and oxygen tubes that met inside this chamber.

Later on in 1938 Dr. Oberth of Germany designed another rocket motor that was also egg-shaped.

Theory of Gravity

The book of Al-Khazini (Abul Fath Abd al-Rahman al-Mansur, astronomer at the Court of Saljuk Sultan Sanjar ibn Malik Shah), *Mizan-al-Hikmah* (The Balance of Wisdom), is a masterly dissertation on mechanics as far as it was developed up to that time viz. 1121 or 1122. It deals with the theory of the balance from an application of the Theorem of Moments and discusses the buoyancy of liquids (and of air also). It gives a table of weights in water of a

1. Willy Levy—Rockets, Missiles and Space Travel (Viking Press, New York, 1951).

number of metals and minerals weighing 100 mithqals in air (leading to remarkably good values of specific gravities), along with a correct explanation of the weights of material bodies as caused by a universal pull towards the Centre of the universe (meaning thereby the earth's centre), and seemingly concentrated at a definite point in each body (its centre of gravity); and remarks in a general way on the weight of the atmosphere.

It is full of important experimental details and recognises the effects of surface tension in liquids. There are references in the book to the construction and use of the immersion hydrometer for determining the densities of liquids (with appreciation of their variation with change of temperature); also to geodesy and levelling and to the measurement of time. The work has been ably described and commented upon by N. Khanikoff in the Journal of the American Oriental Society.[1]

An important treatise on mechanical sciences, *Kitab-al-Ma'rifat al Hiyal-al-Handasah*, dealing chiefly with hydraulic appliances, is available in a German translation with commentaries by Eilhard Wiedemann. It was composed by Abu-al-Izz Ismail ibn Razzaz Badi-al-Zaman al-Jazari at Amid in Diyar Bakr for the Urtaqid Ruler Nasiruddin Mohammad, probably in 1205 or 1206. A critical study of the original Arabic will doubtless throw much light on Arab technique of time-measurement.[2]

Max Meyerhof is of the opinion that meteorological studies were much in favour with the Muslims of the later centuries, particularly those on balances. Al-Khazini, originally a Greek slave who lived about 1200 in Merv (Persia), left a voluminous book, "The Balance

1. Journal of the American Oriental Society, Vol. VI, pp. 1-128. New Haven, 1859, and Mohammad Abdur Rahman Khan, "Science and Culture", pp. 50-51 (Lahore, 1946).

2. G. Sarton, pp. 631-32, Vol. II.

of Wisdom", only parts of which have been edited. He takes up and continues Thabit bin Qurra's investigations of the so-called "Roman" balance, or steelyard, which is itself of Greek origin. His work also includes valuable remarks on specific gravity and the specific weight of alloys. Khazini also dealt with the problem of the greater density of water when nearer to the centre of the earth, shortly before Roger Bacon propounded and proved the same hypothesis.[1]

Baron Carra De Vaux sums up: "Arabic literature contains several treatises on the balance, one of which that of Al-Khazini, is of particular interest. The idea of equilibrium and of gravity is highly developed in it; specific gravities are also discussed."[2]

Ibn al-Haytham in his book "Balance of Wisdom" has discussed dynamical principle, generally supposed to be the monopoly of modern science. He described minutely the connection between the weight of the atmosphere and its density, and how material objects vary in weight in a rare and dense atmosphere.

He has given his views on the submergence of floating bodies, and the force with which they rise to the surface when immersed in light or heavy media; he fully understood the principles of gravitation, and recognised gravity as a force. He knew correctly the relation between the velocities, spaces and times of falling bodies, and had very distinct ideas of capillary attraction.

1. Legacy of Islam, p. 342.
2. Legacy of Islam, p. 388.

CHAPTER 13

Stirring of a New Life

Robert Briffault in his book, the 'Making of Humanity', has honestly expressed the indebtedness of Europe to the Arabs: "It was under the influence of the Arabs and the Moorish revival of culture and not in the 15th century, that a real renaissance took place. Spain, not Italy, was the cradle of the re-birth of Europe. After steadily sinking lower and lower into barbarism, it had reached the darkest depths of ignorance and degradation when cities of the Saracenic world, Baghdad, Cairo, Cordova and Toledo, were growing centres of civilisation and intellectual activity. It was there that the new life arose which was to grow into a new phase of human evolution. From the time when the influence of their culture made itself felt, began the stirring of a new life.

"It was under their successors at the Oxford School (that is, successors to the Muslims of Spain) that Roger Bacon learned Arabic and Arabic Sciences. Neither Roger Bacon nor his later namesake has any title to be credited with having introduced the experimental method. Roger Bacon was no more than one of the apostles of Muslim Science and Method to Christian Europe; and he never wearied of declaring that knowledge of Arabic and Arabic science was for his contemporaries the only way to true knowledge. Discussions as to who was the originator of the experimental method....are part of the collossal misrepresentation of the origins of European civilisation. The experimental method of Arabs was by Bacon's time widespread and eagerly cultivated throughout Europe.

"Science is the most momentous contribution of Arab civilisation to the modern world; but its fruits were slow in ripening. Not until long after Moorish culture had sunk back into darkness did the giant which it had given birth to rise in his might. It was not science only which brought Europe back to life. Other and manifold influences from the civilisation of Islam communicated its first glow to European life.

"For although there is not a single aspect of European growth in which the decisive influence of Islamic culture is not traceable, nowhere is it so clear and momentous as in the genesis of that power which constitutes the permanent distinctive force of the modern world, and the supreme source of its victory—natural science and the scientific spirit.

"The debt of our science to that of the Arabs does not consist in startling discoveries of revolutionary theories, science owes a great deal more to Arab culture, it owes its existence. The Astronomy and Mathematics of the Greeks were a foreign importation never thoroughly acclimatised in Greek culture. The Greeks systematised, generalised and theorised, but the patient ways of investigation, the accumulation of positive knowledge, the minute method of science, detailed and prolonged observations and experimental enquiry were altogether alien to the Greek temperament. Only in Hellenistic Alexandria was any approach to scientific work conducted in the ancient classical world. What we call science arose in Europe as a result of a new spirit of enquiry, of new methods of investigation, of the methods of experiment, observation, measurement, of the development of Mathematics, in a form unknown to the Greeks. The spirit and those methods were introduced into the European world by the Arabs.

"It is highly probable that but for the Arabs, modern European civilisation would never have arisen at all; it is absolutely certain that but for them, it would not have assumed that character which has

enabled it to transcend all previous phases of evolution".[1]

By the tenth century A.D. the intellectual superiority of the Arabs was recognised in Europe. The first Christian to take up the torch of learning was Gerbert (Pope Sylvester 11, d. 1003 A.D.). He introduced Arab astronomy and mathematics, and Arabic numerals in place of the clumsy Roman ones. He was followed by many, especially Constantinus Africanus in the eleventh century A.D., and Bishop Raymond (Raimundo) in the twelfth century A.D. As early as the eleventh century Toledo became a centre for the transmission of Arabic culture and science to Europe. Raymond (d. 1163 or 1164) established a regular school of translation at Toledo. A number of translators flourished there. Among the scholars who flocked to it from all over Europe, were Gerard of Cremona (d. 1187 A.D.), John of Seville (Avendeath) and Gundisalvi (Domenico Gonzales). Under the supervision of Archdeacon Domenico Gundisalvi, and with the co-operation of the Hebrew Johannes ben David, the school of the Archbishop of Toledo rendered into Latin a large number of Arabic works on science and philosophy. Gerard, who was the Hunayn ibn Ishaq of Toledo, translated into Latin more than 70 Arabic books on different subjects. Among his translations were the surgical part of *al-Tasrif* of *al-Zahrawi*, the *Kitab al-Mansuri* of al-Razi and the *Qanun* of Ibn Sina, Banu Musa's works, Al-Biruni's commentary of Khawarizmi, the tables of Jabir bin Aflah and Zarqali.[2] John of Seville under the patronage of Raymond translated several works of Avicenna, Qusta ibn Luqa and al-Farghani. Gundisalvi translated the *Kitab al-Nafs* (*Anima*), the *Kitab al-Shifa* (*Sufficientia*) of Ibn Sina, and *al-Kulliyat* (*Colliget*), with Ibn Rushd's commentary on it.

1. Briffault: Making of Humanity, pp. 190-202.
2. George Sarton: Introduction to the History of Science, Vol. II, pp. 321.

There were many other translators at Toledo who had neither command over the languages nor sufficient knowledge of the subject matter. They translated word for word and, where they failed to understand, Latinised the Arabic words. The Italian Plato of Tivoli, Michael Scotus, Robert of Chester and Hermanus Allemanus (Teutonicus) were other famous translators of the thirteenth century. They flourished at Tarrangona, Leon, Segovia, Pamplona and other northern cities of Spain. Thus Spanish Arabic learning permeated through all Europe. It passed from the portals of Toledo through Provence and the Alpine passes into Lorrains, Germany, Central Europe and England.[1] Constantine travelled for 30 years in Muslim lands and on his return he taught Arabian medical sciences at Salerno and translated Arabic works into Latin. Adelard of Bath was the first of a long series of Arabic scholars of England who travelled extensively in search of Arabic books. He visited Syria, Sicily and Spain. On his return to England he translated several works on mathematics and astronomy. Among the most important works he translated was the astronomical tables of Al-Majriti (1126 A.D.) Several European Orientalists like Mirabilis, after making the tour of the Muslim countries, were so much impressed that on their return home encouraged their students to leave the European schools for those of the Arabs and this yielded beneficial results. The valuable works of the Arab astronomers and scientists were widely studied in Europe and became basis of modern astronomy and science. Most of the names of the stars in European languages are derived from Arabic origin such as Acrab (*Aqrab*-Scorpion) and Pherked (*farqad* calf). In the mathematical vocabulary there are other examples of Arab influence. Algebra, Cenit (zenith), Nadir (nadir the point opposite to the zenith), and Cipher are borrowed

1. Joseph Hell: Arab Civilisation, p. 111 and Bernard Lewis: England and Arabic learning, pp. 2-6.

from Arabic words. Elixir (Ar. *al-aksir*—a kind of medicine), Alcohol (Ar. *Alkohol*—highly rectified spirit of wine), Antimonio (Ar. *antimun*, Eng. antimony), Alcanfor (Ar. *Kafur*, camphor), are examples of medical terms of Arabic origin commonly used in European languages.

"Not till the education of Europe passed from the monasteries to the universities, not till Mohammadan science and classical forethought and industrial independence broke the sceptre of the church, did the intellectual revival of Europe begin."[1]

1. History of Rationalism, Vol. II, p. 206.

CHAPTER 14

Philosophy

The reign of Al-Hakam II was indeed the golden age of Arab learning in Spain. The Caliph was passionately devoted to letters. His agents were sent to all parts of the East to collect rare books. He was himself an erudite scholar and patronised learning. He granted liberal bounties to men of learning and established twenty-seven free schools in the capital. During his reign the University of Cordova gained a prominent position among the educational institutions of the world and attracted students, Muslims, Jews and Christians from different parts of the world—Europe, Africa and Asia. Professors of international repute were invited to adorn the chairs of different faculties of the university and he set aside endowments for their salaries.

It was under Al-Hakam II that the study of philosophy was commenced and cultivated. Among the Muslim philosophers of Spain, Ibn Bajjah and Ibn Rushd occupy the first and foremost place. Besides the honour of having Ibn Rushd for his pupil, it is said of Ibn Bajjah by some Arab writers that if we establish a comparison between his essays and those of Ibn Sina and Al-Ghazzali, the two authors who most promoted the study of philosophy in the Islamic world after Al-Farabi, we shall find the balance inclining rather on the side of Ibn Bajjah.

Doctrines of Absorption and Emanation

The Eastern doctrines of Absorption and Emanation were first introduced by Aristotle into Eastern

Europe. Philo, the Jew, based his philosophy on the theory of Emanation. From the Alexandrian Greeks these ideas passed to the Saracenic philosophers. In the intellectual history of the Arabs, the Jews and the Saracens are continually seen together. From them, conjointly, Europe derived its philosophic ideas, which in course of time culminated in Averroism. Now, Averroism is philosophic Islamism. The works of Ibn Rushd invaded Christendom by two routes; (a) from Spain, through Southern France, they reached Italy, and (b) from Sicily they passed to Naples and South Italy. The doctrine of Emanation and Absorption thus introduced in Europe affected the ranks of intelligence and fashion all over the continent. Even as early as the 10th century, persons having a taste of learning found their way into Spain, a practice in subsequent years still more indulged in when it became illustrated by the brilliant success of Gerbert who passed from the University of Cordova to the Papacy of Rome. Pedro and many ecclesiastics and learned men even from Britain were found studying in Andalusia. Into Italy and England Averroism had silently made its way. It found favour with the Franciscans and was studied in the ancient University of Paris. Michael Scott made the writings of Averroes known by his translations. We meet continually Arabian ideas in Roger Bacon (1214-1294), the forerunner of his great namesake, and eventually in Spinoza (1632-1677). The Aristotelian or Inductive Philosophy, clad in the Saracenic costume and given by Ibn Rushd found favour with Leonardo da Vinci (1452-1519), to whom some would attribute the Renaissance of Learning in Europe. Bertrand Russell commenting on Averroism writes in his History of Western Philosophy: "Averroes is more important in Christian than in Muslim philosophy. In the latter he was a dead end; and in the former, a beginning. He was translated into Latin early in the 13th century by Michael Scott; as his works belong to the latter half of the 12th century, this is surprising. His influence in Europe was very

great, not only on the Scholastics, but also on a large body of unprofessional free-thinkers, who denied immortality and were called Averroists. Among professional philosophers, his admirers were at first especially among Franciscans and at the University of Paris."[1]

Muslim Influence

The close contact of Muslims and Christians not only influenced their culture and mode of living, but also their religion. Many Christian youth, after receiving education at any university of Spain under Muslim or Jewish professors, went back to their land to rise against the Pope and Bishops. Claudius, who was born and bred in Muslim Spain, on being appointed Bishop of Turin in 828 A.D., defaced, burnt and abolished all statues and crosses in his bishopric.

The Arab influence was no less felt in the philosophical productions of the Christian Spain and Europe. The sketch of this influence known as Christian philosophy was drawn by Raymond (Raimundo Lulio) who was the direct disciple of the Spanish Muslim philosopher, Muhyuddin ibn al-Arabi. In the Toledan school many philosophical works were translated from Arabic into Latin and some originals were written. The Jewish scholar, Gundisalvi or Domenico Gonzalez, wrote some original works like the book of *Immortalitate Animae*, which shows the doctrines of Avicenna and Abengabirol, the book of *processione mundi* based on Oriental and Neo-Platonic theories and the book of *divisions philosophiae* based mainly on Al-Farabi's books. The book of the *doce sabious ylas Flores de Filosofia* (twelve wise men and the flowers of philosophy) initiated the Muslim influence. Many commentaries were written on the works of Ibn Bajjah, Ibn Rushd, Ibn Al-Arabi and *Hayy ben Yaqdan* of Ibn Tufayl (12th century) or the philosophy *autodidacto*.

1. Bertrand Russell; History of Western Philosophy, pp. 419-420.

Men like Roger Bacon read Averroes and other Muslim philosophers. "His learning seems to have been unique; he read Aristotle in Greek, and expressed unmeasured contempt for the Latin translations then in vogue; he was acquainted with the writings of the Arabian men of science, whose views were far in advance of all other contemporary knowledge. He does not appear himself to have made the original scientific discoveries with which he used to be credited, but he had thoroughly mastered the best of the science and philosophy of his day."[1] Arabic philosophical ideas are reflected in the works, especially *Divine Comedia* of the Italian poet-philosopher, Dante (1265-1321) and in the leading ideas of the other poets of the *dolce stil Nuovo*.

Dante's Sources

According to Ozanam, a 19th century French scholar, "two roads, one going north and the other south, lead Dante to the old Eastern sources". He maintained that the relationship between the Saracens and Europe was very close at that time. Dante had read the Latin versions of the works of many Muslim philosophers and adherents of *tasawwuf*, at least those of Ibn Sina and al-Ghazzali. Following Ozanam and d'Ancona, Charles Labitte, in his preface for Brizeux's translation of the Divine Comedy into French, maintained that the theme must have been borrowed from the world of Islam. At that time Modi de Goeje and some other authors held similar views. More recently, Edgard Blochet published two studies on this subject: *Etudes sur l' mistoire Religieuse d' l' Islam*, 1889, and *Les Sources de la Divine Comedia*, 1901. In these studies he defended the view that the idea of ascending to heaven came directly from Islam. .....Blochet claimed that the idea of ascending to heaven in Dante was transmitted both from Persian and Islamized sources.

1. W. R. Sorley, A History of British Philosophy to 1900, pp. 5-6, Cambridge, 1965.

"Asin Palacio's conclusions are more precise. He studied the sources of Dante and thereby demonstrated how these depended on Islamic works i.e. on their translations. By emphasizing the special significance of Ibn Arabi's "Revelations", he solved the problem with great success. Ibn Arabi's doctrine of *tasawwuf* influenced the Western Scholastics, the priests of the Franciscan denomination and Dante".

"Islamic books entitled *Mi'raj Namah* give the same amount of details and demonstrate the same kind of skill in the description of the heavenly world as is to be found in the Divine Comedy. The eyes of both travellers are dazzled by getting near God as they enter a new phase of the *Mi'raj*. When their respective guide Gabriel or Beatrice informs them of His grace, their eyes open. Gabriel and Beatrice not only serve them as guides, but also pray for them at each post. As finally Beatrice leaves her place to Saint Bernard when Dante enters heaven, so does Gabriel leave the Prophet Mohammad when he advances to the presence of God guided by a ray of light. In studying Dante's Muslim sources, one has to compare the Divine Comedy with the Arab poet Abu al'Ala at Ma'arri's *Risalat al-Ghufran*. There is a close relationship between the religious ecstacy, charitable pity and irony, orienting the feelings of the author of this book and the religious ecstacy, criticism, satire and irony of Dante".[1]

Prof. M. M. Sharif correctly remarks: "Muslim philosophy influenced Western thought in several ways. It initiated in the West the Humanistic movement; b) introduced the historical sciences; c) the scientific method; d) helped the Western Scholastics in harmonizing philosophy with faith; e) stimulated Western mysticism; f) laid the foundations of Italian Renaissance and, to a degree, moulded the modern European thought down to the time of Immanuel Kant, in certain directions even later.

1. History of Muslim Philosophy, Vol. II, pp. 1356-58.

"The Muslims were the first humanists and they gave a humanist bent to the Western mind. They were the first to reveal to the West that outside the prevailing Catholic Church it was not all darkness and barbarism but untold wealth of knowledge. They captured and further developed all the intellectual achievements of Greece and transmitted them to the West before any direct contact between the Greek intellect and the Western mind was established. It was through their influence that ancient and contemporary men outside the Christian West also began to be looked upon as human and even possessed higher civilisations".[1]

The influence of Muslim philosophers, especially of Avempace (Ibn Bajjah), continued in Italy upto the 16th century, and gave rise to the famous disputes between Achillini and Pomponazzi. St. Thomas Aquinas also seems to be greatly influenced by the writings of Ibn Rushd and Ibn Sina.

Immanuel Kant

The great philosopher Kant also praised Islam in his *La Religion dans les limites de la simple raison* (Religion within the Bounds of Mere Reason, 1793). "Islam", he thinks, "distinguishes itself with pride and courage, for it propagates faith not by miracles but by conquests, and it is founded on courageous asceticism. This important phenomenon is due to the founder who propagated the conception of the unity of God. The nobility of a people who were freed from idolatry has been an important factor in bringing about this result. The spirit of Islam is indicated not in conformity without will but in voluntary adherence to the will of God, and this, above all, is a noble quality of a high order".[2]

1. M. M. Sharif, "Muslim Philosophy and Western Thought", Iqbal, Vol. VIII, No. 1, Lahore, July 1959, pp. 1-14.
2. E. Kant, La Religion dans les Limites de la Simple Raison, French translation by J. Gibelin, J. Vrin, Paris, 1943, pp. 230-40.

CHAPTER 15

Influence of Sufism

A mention of Averroism—or the doctrine of Emanation and Absorption, that the soul of man has emanated or issued from God and shall finally be absorbed into God—naturally leads one to say a word or two on Sufism, which has also exercised its influence on the Western thought. Sufism owes its origin to a small Persian sect whose followers early struck out a path for themselves by discarding all costly robes and clothing themselves in black coarse woollen garments (*suf*). These were henceforth known as Sufis, and their way as *tasawwuf*. Abu Hashim was the first to bear the name of Sufi. Dhun Nun al-Misri may be said to have given Sufism its permanent shape. By the end of the 3rd century A.H. Quietism had changed into Pantheism and kindled a belief that the Beloved and Lover are one and identical. Two theories are advanced as to the origin of Sufism; (i) Reaction of the human mind from the Transcendental to the Immanent type, and (ii) Neo-Platonic influence.

It is highly probable that the seven philosophers who were forced to leave their homes because of the tyranny of Justinian, who forbade the teaching of Philosophy at Athens, should have exercised considerable influence upon a few of the more thoughtful Persians when these Neoplatonists paid a visit to the Persian court in the 6th century, as Neoplatonism is the doctrine of Ecstacy and this bears directly upon Sufism. These points form a broad outline of Sufism. The later Sufis elaborated the ideas, gave them a rich and beautiful setting and built about them one of the

most interesting phases of mystical poetry the world has ver known. They, however, changed the Neoplatonist's purely abstract conception of God to an essentially personal one, and were strongly opposed to a distinct personality from the Beloved.

Finally, the "Abu Bram" of the Indian Vedantists found an echo in the "*Anal Haq*" (I am the Truth) of the Sufi Husain bin Mansur Al-Hallaj (died 922 A.D.), who had to pay with his life for this utterance. His mystic theory has been clearly expressed in these verses:

"I am He whom I love, and He whom I love is I,
We are two souls dwelling in one body,
When thou seest me, thou seest Him,
And when thou seest Him thou seest us both".

Allama Shibli's remarks that *Tasawwuf* is control of the faculties and observance of breath, certainly points to the belief that the later Sufis got certain ideas from the Vedantic Philosophy. In seeking to submerge themselves in God, the Sufis arrived at the Indian conception of "The All-One."

William James

All Pantheistic methods and utterances are curiously alike. In William James book, Varieties of Religious Experiences, we read: "This overcoming of all the usual barriers between the individual and the Absolute is the great mystic achievement. They say that in mystic states we become aware of our oneness. This is the everlasting and triumphant mystical tradition, hardly altered by differences of clime or creed. In Hinduism, in Sufism, in Pantheistic Christian mysticism, we find the same recurring note, so that there is about mystical utterance an eternal unanimity which ought to make a critic stop and think and which brings about that which the mystical classics have, as has been said neither birth-day nor native land. Perpetually

telling of the unity of man and God, their speech antedates language and they do not grow old. Every man, says the author of *Gulshan-i-Raz* whose heart is not longer shaken by doubt, knows with certainty that there is no being, save only one. In this divine majesty theme, the we, the thou, are not found, for the one there can be no distinction. Every being who is annulled and entirely separated from himself. . bears. . . . . "I am God". In the vision of God, says Plotinus, what one sees is not our reason, but something prior and superior to our reason. He who thus sees does not .....see two things. He changes, he ceases to be himself, preserves nothing of himself. Absorbed in God, he makes but one with him, 'Here', writes Heinrich Suso, 'the spirit dies, and yet is all alive in the marvels of the Godhead".

As regards the influence of Sufi poetry on Western thought, it may be noted that many of the European mystics wrote as the Sufi poets had written before them, particularly Thomas Aquinas, Eckhart and Dante. The greatest names in the realm of mysticism are those of Johann Tauler and Heinrich Suso, who were the pioneers of the early mystic movement, "the Minnesinger of Gottesminne". Their writings were intensely practical and touched on all sides the deeper problems of moral and spiritual life, and made the mystic movement in its later manifestations so important a forerunner of the Reformation. In the 19th century Hegel was loud in the praise of Jalaluddin Rumi. The same influence is found in Didactic Literature, Ibsen's Caesar and Galilean. Goethe was greatly influenced and inspired by Hafiz of Shiraz, an Iranian poet of the 14th century, a fact which Goethe acknowledges in several places in his *West-Ostlichar Divan*.

Influence on Goethe

The currents of oriental thought penetrated deep into German literature and some of the distinguished

poets like Hafiz, Anwari, Nizami and Sa'adi[1] left an abiding impress on the minds of Goethe and other poets and thinkers. But Goethe (1749-1832), was most remarkably influenced and inspired by Hafiz of Shiraz, an Iranian poet of the 14th century. The publication of Von Hammer's German translation of the Diwan of Hafiz in 1812 opened a new vista of life for him. He seemed to have found a kindred soul in Hafiz whose poetry promised to offer some relief from the depression and the inner struggle he was experiencing in the chaotic Europe of Napoleon Bonaparte (1769-1821). Goethe who had always sought the primal phenomena of organic and artistic life was introduced through Hafiz to a new world, the simplicity, the pristine glory and timelessness which made him feel that he had come upon the primal form of life. The clearly personal strain underlying the *Divan* makes it, in the words of Ernst Beutler, a guide book, a book which one has to live and which with "Faust" has become the most important and personal work of the poet.

Goethe's *Divan* represents a definite phase of the poet's life and it also reveals certain basic characteristics of his mind in a clear form. Varied though are the contents of this small collection of poems, Hafiz and Zuleikha are the central figures dominating the entire scene. The poetry of Hafiz aroused in Goethe great admiration. He called Hafiz the "Master" and tried to imitate his forms of expression and poetic technique.

Hafiz appeared to Goethe as an oriental brother, a kindred soul who alone could become an intermediary between himself and the East. In short, Goethe actually saw in Hafiz his own features reflected—freedom from official doctrines and institution, respect for the individual vis-a-vis the State, the Church, the Mass and ZEITGEIST—and finally his ability to Maintain a harmonious relationship between the earthly pleasures

1. Emil Ludwig, Goethe, p. 482, 1934.

and the Divine Ground—all these features had found the most eloquent and sweetest expression in the poetry of Hafiz.

It cannot be gainsaid that in his *Mahomet Gesang*, Goethe, with great sympathy and enthusiasm, pays immortal tribute to the greatness of the Prophet's personality and describes the power of the new faith exalted against idolatry, and the sincere adherence of its believers to it. This work of Goethe is in the nature of answer to Voltaire's work bearing the same name (Goethe, Mahomet, French translation). Goethe read the Quran in 1770 and annotated certain verses which were later referred to in Megerlin's German version of the Quran. By this time the Prophet of Islam was well-known in Germany as the founder of a "Natural Religion", and a protagonist of intellectual advance. Megerlin's translation of the Quran (1772) and that of Boysen's (1773) were published in Germany in addition to Turpin's work, "The Life of Mohammad", in which Mohammad is described as a "Great Prophet", "powerful mind", "true believer" and the "founder of a natural religion".

There is a vivid description of the effect the Quran had on Goethe. He found the heart and kernel of Islam in the Second Surah, al-Baqarah which begins as folows:

"This is the Book. There is no doubt in the same.....". "And in this wise and manner", says Goethe, "we have *Surah* after *Surah*. Belief and unbelief are divided into higher and lower. Heaven and hell await the believers or deniers. Detailed injunctions of things allowed and forbidden, legendary stories of Jewish and Christian religion, amplifications of all kinds, boundless tautologies and repetitions, form the body of this sacred volume, which, to us, as often as we approach it, is repellent anew, next attracts us ever anew and fills us with admiration, and finally forces us into veneration".

While making a general review of Islam as a dynamic force, Goethe says to Eckermann: "You see this teaching never fails; with all our systems we cannot go, and generally speaking, no one can go, any further."

Islamic Monotheism (*Tauhid*) exercised a far-reaching influence on him, he therefore, believed that Prophet Mohammad "had succeeded in conquering the world through the conception of the unity of Allah".[1]

Further paying homage to Islam, Goethe said: "If Islam means submission to the will of Allah, all of us live and die in Islam".[2]

Auguste Comte

Auguste Comte (1798-1857), French philosopher and exponent of Positivism, in his "Law of Three Stages of Social Development", considers Islam to be the most advanced phase in his so-called theological stage and regards it even as preparatory to the metaphysical stage.

Nietzsche

Although Nietzsche (1844-1900), German philosopher, severally attacks Christianity in all his works, particularly in his Antichrist (*Der Antichrist*), he did not include Islam in his adverse judgement. On the other hand, he mentioned it with praise.[3]

Voltaire

Voltaire (1694-1778), the author of Candide, seems to be deeply influenced by the writings of Muslim thinkers, philosophers and mystic poets. He was a great foe of superstition and unreason. He condemned the monstrous cruelty of the Church in torturing and burning men who dared to question its dogmas and doctrines. He vehemently criticised the

1. Quoted by Professor Dr. Gruitzmacher, *Moslemisohe Revue*, Berlin, Vol. XIII, pp. 81-82.
2. *Ibid.*
3. History of Muslim Philosophy, Vol. II, p. 1353.

arrogance and grandiloquence of the religious order and pleaded for social justice and fraternity. As a historian, dramatist, philosopher and satirist he moulded the minds of the people during the most critical period of the French Revolution (1789-1799).

Rousseau

Rousseau was considerably influenced by the democratic concept of Islam and laid the foundations of democracy in Europe. His most significant writings on political theory were "Social Contract" (1762) and "Discourses on the origin of Inequality" (1755), in which he advocated the cause of "Liberty, Equality, Fraternity and human Brotherhood". He believed that sovereignty is indivisible, and that all of it became vested in the community. His dogma of equality and popular sovereignty became the rallying cry of the revolutionaries. He exercised a tremendous influence on the minds of the people and changed the course of history.

W. R. Sorley how correctly comments: "Equality and freedom were held to be natural rights of which men had been robbed by governments and the purpose of the revolutionists was to regain and realise those rights. This mode of thought was represented in England by Richard Price; through Rousseau it came to dominate the popular consciousness; in the American Declaration of Independence of 1776 it was made the foundation of a democratic reconstruction of government."[1]

1 A History of British Philosophy to 1900, p. 229.

CHAPTER 16

Economic, Social and Cultural Influence

Arab influence was more so felt on the economic life of the Europeans, especially the Spaniards. They are indebted to the Muslims for the introduction of rice, sugarcane, cotton, and an infinite variety of fruits. The Muslims developed the agricultural resources of the country to the advantage of the industry and commerce. This was one of the lasting gifts of the Muslims to Spain. The Christians, after the reconquest of the districts and towns inhabited by Muslims, adopted the existing institutions without much change, as is proved by the charters granted by the kings of Aragon and Castile to the inhabitants of the conquered cities. The Christian states of the North did not have their own coins but used those issued by the Muslim mints. Alfonso VII minted maravedi at Toledo in imitation of the coin of the Almovarids. It was not only current in medieval Christian Spain but is still in use in some parts of Spain. Ramon Berenguer I copies the coins of Yahya ibn al-Qasim.[1] The Christians followed the agricultural and industrial policies of the Muslims. Paper mills and textile industries were opened in European countries in imitation of those of the Muslims of Spain.

The influence of Arabic on the daily economic life of Spain is so great that the Spanish language has Arabic words in the actual toponymy, which is commonly found in the Spanish dialects of the South.

1. A. G. Palencia: Historia, p. 198.

In the agricultural field certain especial technical Arabic terms still survive. In irrigation the terminology with rare exceptions has continued to be Arab, though their system of irrigation had been very much influenced by the earlier Visigothic and Roman types The Arab names dominate in the case of rivers; for example the *Guadalquivir* (Ar. *Al-Wadi-al-Kabir*—the great river); *the Guadalaviar* (Ar. *Al-Wadi-al-Abyad*—the white river) etc. Almost all Spanish words carrying the meaning of water for drinking or irrigation purposes have been derived from Arabic roots, for example, the *Azequia* (Ar. *al-saqiya*), a camel carrying water for irrigation; *Noria* (Ar. *al-naura*), Persian wheel for drawing water from a well; *Azud* (Ar. *al-sud*—well, obstruction, dam); *Aljibe* (Ar. *al-jub*) well; Chorro (Ar. *khorro*), the noise produced by running water; *Alfarada* (Ar. *al-farada*) duty paid for the irrigation of land; *Almenara* (Ar. *al-minhar*), a channel which carries back the surplus water in irrigation etc.; *Mar de Zacac* (Ar. *Bahr al-Zaqaq*), Sea of Syria, i.e. East Mediterranean sea; *Mar de Ciran* (Ar. *Bahr Tirren*), Mediterranean sea; *Albufera* or *Albuhera* (Ar. *al-buhayra*), small sea; *Alberca* (Ar. *al-birka*), tank or pond; *Safareche* (Ar. *saharij*), cistern or reservoir; *Alcantara* (Ar. *al-qantara*), the bridge; *Alcantrilla* (Ar. *alqantara*), a small bridge, drain.

The Muslims introduced a large variety of corn, fruits, flowers and plants in Spain of which the botanic dictionary of Spanish language still bears testimony, for example, *Sandia* (Ar. *sindiya*), melon of Sind; *Cafari* (Ar. *safari*), the traveller; *Moz*, *Mussa* or *Mossa* (Ar. *mauz*), banana; *Almez* (Ar. *almis*), the lote-tree; *Alberchigo* (Ar. *alfarsaq*), peach; *Berenjena* (Ar. *badhanjan*), eggplant; *Azahar* (Ar. *al-zohor*); flower; *Azafran* (Ar. *al-zafaran*), saffron; *Arroz* (Ar. *arruzz*), rice, orange-flower; *Jazmin* (Ar. *yasamin*), jasmine; *Azucar* (Ar. *sukkar*) Sugar; *Aceituna* (Ar. *zaytun*), olive etc.

The whole of Levante (eastern) and southern parts of Spain were industrialised by the Muslims whose successors, the Christians, have still preserved many Arabic names, for example, *Algodon* (Ar. *al-qutn*), cotton; *Al-formbra* (Ar. *al-khamra*), floor-carpet; *Ajorca* (Ar. *al-shirka*), Moorish trimming ring worn about the wrist or ankle; *Alpargata* (Ar. al-*barghal*), shoes or sandals made of hemp; *Chupa* (Ar. *jubba*), waist-coat jacket; *Carro* (Ar. *Karro*), two wheeled cart; *Jabega* (Ar. *Shabka*), a Moorish wind instrument; *Almirez* (Ar. *al-mihras*), a brass mortar; *Anafre* (Ar. *al-furn*), portable stove or furnace; *Alcancia* (Ar. *al-kanziya*), money-box; *Al-bornia* (Ar. *albarniya*), a large glazed jug; *Tahonero* (Ar. *Tahuna*—mill) miller, who manages a horse mill; *Alfarero* or *Alfahorero* (Ar. *al-fakhkhar*), potter; *Albardero* (Ar. *Bard'a*; Fr. bardz'a—Saddle), pack-saddle maker; *Atarzana* (Ar. *dar Sana*), dockyard, magazine; *Alvexi* (Ar. *al-wusha*), brocade; *Altiraz* (Ar. *al-tiraz*), silken dress embroidered by hand; *Algupa* (Ar. *al-jubba*), a short gown; *Allihaf* (Ar. *al-lihaf*), wrapper; *Dibajo* (Ar. *debaj*), silken stuff; *Mobatana* (Ar. *al-mubatana*), gloves of skin; *Barro* (Ar. *barro*), mud, clay; *Garbillo* (Ar. *ghirbal*), sieve; *Atutia* (Ar. *tutiya*), a mineral; *Azofars* (Ar. *al-sofar*), yellow, a yellow metal, brass; *Arrope* (Ar. *al-rob*), a kind of sweetmeat; *Burdo* or *Burda* (Ar. *burda*), coat, cloak; *Almojabana*, cake made of cheese (Ar. *al-jubbana*), a woman who makes cheese.

As we still see in modern markets, merchandise was separated and sold by the Muslims in large stores in order to facilitate shopping. As a reminder to the Arabs, many market places in the medieval towns of the Muslims still have Arab names in Spanish garb, and many Arabic words in relation to marketing are current in modern Spanish, for example, *Almocen* (Ar. *al-makhzan*), shop; *Alcaiceria* (Ar. *al-qaysariya*), market place for raw silk, royal market; *Almoneda* (Ar. *munada*), sale by auction; *Zocco* (Ar. *Suq*), narrow street on both sides of which are shops of a particular

trade; *Fonda* (Ar. *fundaq*), a large inn for foreign merchants to live and exhibit their goods; *Alfondica*, *Alhondiga* (Ar. *al-fundaq*), market place, a public granary etc.

Most of the Spanish names for measures and weights have been derived from the Arabic words; for example, *Kilate* (Ar. *qirrat* or *qirat*), a weight of four grains; *Daniquo* (Ar. *daniq*), a weight of two Kirites; *Mizcal* (Ar. *Mithqal*), a weight of 1-3/7 drachms; *Arralde* or *Arrelde* (Ar. ritl), a pound of twelve ounces; *Quintal* (Ar. *qintar*), a measure of weight of 100 lbs.; *Xeme* (Ar. *Shama*) a span; *Cantara* (Ar. *Qantara*), a measure for milk, wine and other liquids.

Apart from these influences, Islam had lent its print on Italian art and architecture. Mention may be made of St. Maria in Piano, an ancient church in a small town named Lorento Aprutino. The interior of this church still bears paintings done by an unidentified artist in the thirteenth or fourteenth century. These paintings present a picture of the "Day of Judgment" and of souls trying to cross *Pul-Serat*, a narrow bridge which, according to Muslim belief, will have to be crossed by every soul before entering Paradise. This pictorial motif of Muslim origin is all the more significant for being recorded in a region (Abruzzo) which, unlike Sicily, is far distant and was never under direct Muslim rule. Another church about 30 kilometres from the one already mentioned, St. Maria de Lago near Moscufo, contains a beautiful 12th century pulpit. Its decoration indicates a clear evidence of Muslim influence, for its various motifs are an imitation of Kufi characters.

It is a historical fact that the last stable nucleus of Muslims in Italy was the colony at Lucera in northern Apulia, near the Abruzzo border; it survived till 1300 A.D. when it succumbed to the intolerance of Charles of Anjou. After the unsuccessful Muslim revolt of Ibn Abbad in Sicily in 1223, Frederick II concentrated

the surviving Sicilian Muslims there, who numbered about 20,000. With no hope of political revival, they at least enjoyed a peaceful existence at Lucera for nearly 100 years.

The most conspicuous Muslim paintings in Italy are of the Palatina Chapel in Palermo, the capital of Sicily, which was directly governed by Muslims from the 9th to 11th Century. History has recorded that a considerable number of Muslims remained there till the 13th Century. Even if a few visible traces have remained of that epoch of direct Islamic rule, a whole trend of architectural style is very important; commonly known as Arab-Norman, it grew up after the Norman conquest at the end of the 11th Century.

The son of the conqueror, Roger II, was particularly tolerant towards the conquered population, but a friendly attitude towards Islam still continued at a later date. This is clearly verified by the Valencian traveller, Ibn Zubair, who visited Sicily towards the end of Norman domination in 1185 A.D. He writes: "It was a great surprise for me to find to what extent this Christian King avails himself of the work of Muslims. Almost all his valets and pages have remained secretly Muslim and are bound to the law of Islam. He places the most important affairs of the Kingdom in the hands of Muslims in whom he reposes great confidence and trust," and goes on to remark, that King William II was fully conversant with Arabic and even wrote and spoke in that language. His Muslim Ministers observed the fast of Ramazan, and that also the Christian women of Palermo spoke Arabic like the Muslims and veiled themselves as they did.

Norman architecture in Palermo, as some buildings prove, was clearly influenced by Arab taste, and some of the very names, still preserved, are Arabic. A modern Muslim tourist who visits Palermo is surprised to find himself in a square or quarter that is still called *della Kalsa* (from *Al-Khalisa*) and he may

still visit what was once one of the finest Arab and Norman parks that *della Favara* (from *al-fawwara*). It was first created by the Emir Ja'afar (997-1019), completely transformed later by the Norman kings and Frederick II, and extolled by Arab and Christian poets; for its form was typically that of the Persian "paradise-garden".

The church of St. Cataldo (1161) with its pure oriental line, external colonnades, and three small red-hued cupolas, resembles a mosque though intended from the start as a church. Then on the site of an older mosque, there is the church of St. John of the Hermit, built under Roger II in 1132. Its simple structure and red domes evoke the charm of the Oriental world which the Arabs brought to Palermo. Also strongly inspired by Arab architecture is another Norman church the Martorana, dating from the age of the Norman kings (1145 A.D.). The Arab influences on architecture are also evident from the Islamic names of places *La Zissa* (from *al-Aziza*, "the splendid"), the construction of which was ordered by William I; of the *Cuba* (*al-Qubba*) dating from the time of William II (1180 A.D.), together with the nearby *La Cubula* or "small Cuba" which was built at the same time. The splendid church of Monreale (12th Century) situated high above Palermo, with its apse decorations and famous "oriental corner" in the cloisters enclosed by three Moorish colonnades on each side with a fountain in the middle, contains something wholly familiar to every Muslim.

The most important Muslim-style pictorial work in Sicily and in Italy, as mentioned before, is the group of paintings on the ceiling of the Palatina Chapel of Palermo which includes purely Arab figures and decorative motifs. This is the chapel of the Norman royal palace, one of the towers of which, the "Pisan tower", has borrowed its characteristic shape from the north African one of *Qasr al-Manar* belonging to the *Qala'* (Fort) of Ibn Hammad (11th Century). It

consists of an almost square central core containing a single room on every floor; between it and the outer wall, there is an ambulatory—four corridors on every side of the central part. The Chapel, founded in 1132-1140 by Roger II, has a wooden ceiling decorated with splendid *muqarnas* and lavish symbolical and figurative paintings, the work of unknown Muslim craftsmen who were employed by the Norman Court. Apart from the ornamental motifs like peacocks, palms, falcons, etc. that complete cycle of images—well-known to every connoisseur of Persian miniatures—that might be called the "classical Muslim cycle of the aristocratic life", can also be observed. Monneret de Villard, who is the best guide to these paintings and has published them in all detail, has discovered countless motifs of Iranian origin.[1]

1. Alexandero Bausani, 'Islamic Impact on Italian Culture", *The Pakistan Times*, Lahore, December 10, 1965.

CHAPTER 17

Household Essentials and Games

Chairs (*Kursi*), raised seats and sofas (*diwan*) came into fashion among the elites during the Islamic period. They used wooden tables inlaid with mother of pearl, ebony or tortoise-shell. Wasik had a table made entirely of gold. A large round tray of silver, tinned copper or brass, covered with a white cloth, was placed on each of these tables with dishes, which were either of silver or chinaware. Spoons made of ebony or china were provided along with plates. Two pronged forks, called *janjal* (Persian *changal*) were common among the rich, and each person used a napkin as well.[1] The system of Menu for luncheons and dinners was introduced by the Arabs long before Europe trod on the path of civilisation. The host gave the details of the dishes for the Menu to the servant who prepared *Kharita-al-Ta'am* or *Ruqqa-al-Ta'am* (Menu) for the occasion.[2]

A number of outdoor games were common. Archery, shooting with the arquebus, polo (*chaukan*), hockey (*suljan*), throwing of spears (*jarid*), wrestling, fencing on foot and on horseback were the principal games. Cricket was not unknown, and tennis (*Lub-ul-Kurah*) was played by both sexes. Respectable young ladies practised fencing and archery and amused themselves with terpsichorean performances. Swimming was also not neglected. Hunting and riding were common pastime of the nobles and the rich. Hisham

1. De Sacy, *Chrest Arabe*, Vol. II, p. 481 and History of the Saracens by Ameer Ali, pp. 458-459.
2. Al-Mustatrif, Vol. I, p. 149.

(724-744) was the first ruler to introduce races in order to improve the breed of the horses. He possessed as many as 4,000 horses for his own and other stables which, according to Masudi, is without precedent.[1] Even princesses and high ranking ladies took active interest in races and maintained stables at their own cost.

Social reunions and conversaziones were frequent among the elites. There were literary, social and cultural clubs as well as political societies to develop and improve the geographical, historical, mathematical, philosophical and scientific knowledge of the people. Learned discussions were held on all phases of human activity. The political societies were generally known as *Dar-al-Nadvah*. Special interest was taken for popularising the fine arts by holding discussions on music and painting and competitions were held and awards given to the best participants.[2]

Ameer Ali writes, "The Saracen lady was an undisguised spectator at the frequent jousts and tournaments which enlivened the capital, and her presence at the public festivals lent a charm and fascination to the scenes. The dignified association of the sexes gave rise to a delicacy of sentiment and refinement of manners.[3]

Chess was an intellectual pastime and "the royal game" and occupied an important place in the higher strata of society. Modern western chess is the direct descendant of an ancient game brought by the Arab merchants from the Indo-Pakistan subcontinent and handed on by them to the Muslim world and finally borrowed from Islam by Christian Europe.[4]

1. Ameer Ali—History of the Saracens, p. 197.
2. Aghani, Vol. I, p. 108.
3. History of the Saracens, p. 519.
4. H. J. R. Murray, A History of Chess, Oxford, 1913.

In ancient India during or before the 7th century it had long been used as an instrument of divination and in time of war, the movement of its pieces frequently directed the evolution of the armies on the march and in battle. Its Sanskrit name was Chaturanga. It was prevalent in Arabia and it followed everywhere in the train of Muslim armies. In Spain it was universally popular. The chessmen of the Caliphs were made of precious metals, others were curiously carved of ivory, most of them were incrusted with gems. The boards were of ebony and sandal wood inlaid with gold. It became one of the favourite diversions of the Court.[1]

In most European languages the game is named after the King (Persian, *Shah*, medieval Latin *Scaci*, chessmen), but the Spanish word *ajedrez* (formerly *axedrez* or *acedrex*), and the Portuguese *xadrez* are derived from the Arabic name for the game itself: *al-Shatranj*. Several of the terms still used in chess are Persian: "checkmate", *Shahmat*, which means that the King is defeated or dishonoured. The earliest authority on chess is Masudi, an Arab author writing (950) who states that *shatranj* existed long before his time.

The Persian poet Firdausi, in his historical poem *Shahnama* gives an account of the introduction of Shatranj into Persia in the reign of Khosru I Anushirvan (531-579) to whom came an ambassador from sovereign *Hind* with a chess board and men asking him to solve the secrets of the game.[2]

The first description of the game in a European language is that of Alfonse the Sage. His book is obviously compiled from Arabic sources and the miniatures usually show players in oriental dress. Sometimes they are accompanied by oriental musicians.

1. History of the Moorish Empire in Europe, Vol. III, Chapter XXX.
2. Encyclopaedia Britannica, p. 460. Vol. 5, 1973.

while now and then the musicians may be seen having a game by themselves, holding their instruments ready in the left hand, in case they are suddenly called upon to play them.[1]

Cards were known to the Arabs before the advent of Islam. Backgammon and draughts were also familiar to the Moors. The feats of jugglers were a source of popular amusement in medieval Cordova. Itinerant minstrels and extemporaneous rhymes also contributed to the entertainment of the court and the nobility.

1. J. G. White, The Spanish Treatise on Chess play written by order of King Alfonso the Sage, in the year 1283 and Legacy of Islam.

CHAPTER 18

Contribution to Music

Fine arts and music played an important role in the social and cultural life of the Muslims. Ziryab and, after him Abul Qasim Abbas Ibn Firnas (d. 888 A.D.), the versatile poet who introduced music as one of the subjects of quadrivium (arithmetic, geometry, astronomy and music) at Cordova, exercised a far-reaching influence on the civilisation of the West. He also introduced the art of fabrication of glass. In addition, he made the clouds thunder, produced lightning in his laboratory, and made an attempt to fly.[1]

Ziryab

Ziryab was the pupil of the celebrated Ishaq al-Mausili at Baghdad. The Caliph Haroon al-Rashid inquiring whether Ishaq had no new singer, he replied, "I have a disciple who sings well and I trust he will one day do me credit". He was presented to the Caliph and impressed him with his superb performance. Haroon was so much enchanted by his dexterity and perfection of art that he rewarded him lavishly and made him stay in his court.

After the death of Harun al-Rashid in 809 A.D., Ziryab went to Spain in 821. During Abdur Rahman II's rule he received the patronage of the Caliph with a high salary and princely privileges.

The Caliph held him in high esteem and not only listened to his songs but discussed with him history,

1. Hitti, History of the Arabs, p. 598 and Levi-Provencal, *La Civilizacion Arbe*, p. 73.

poetry, art, science, astronomy and geography, for Ziryab was a Pico de la Mironadola who took all knowledge for his province. He entertained the Caliph with stories from his prodigious memory, and became very close to him as one of the members of the royal family, dining with the Caliph and even receiving a key to the palace.

In addition to all these accomplishments he had the priceless gift of tact and charm, which enabled him to spend the rest of his life in perfect serenity as the arbiter of elegances of a court. Never before or after, says Al Maqqari, was a man so universally popular and admired: princes and high dignitaries modelled themselves on him. He was gifted with penetration and wit, and profoundly versed in polite literature and was infinitely entertaining.

He also introduced a number of Iranian refinements into toilet, including what may have been a deodorant, and added new lustre to the sovereign's appearance by adding salt to the rose-water in which the royal garments were washed.

On the culinary side he was no less resourceful: he was the first to discern the virtue of the asparagus that grew wild in Andalusia, he created *aperitifs* such as rissoles and a triangle of pastry fried in oil of coriander seed, besides a dish whose recipe has not been preserved, *fritto misto alla Ziryab*.

Al Maqqari credits him with teaching the fashionable to drink out of glass instead of plate, and to serve their meals on linen cloth.... But the greatest achievement that brought him lasting fame wherever oriental music is heard was his invention of the fifth string of the lute. The remaining strings, which were of different colours, represented the supposed four humours of the human body; that of Ziryab was presumed to represent the soul.[1]

1. Spain under the Muslims, Edwyn Hole, pp. 165-69.

According to Ribera, Spanish music was transmitted to Europe through the Arab merchants who brought new musical instruments to Europe. Music began to make new progress when it was no longer a mere preservation of ancient ecclesiasticai chants. By reading in the Spanish universities the Europeans were directly benefitted by the Arab fount. George Sarton in his monumental work remarks that the new musical theories, filtering through from Arab writings into Latin and Hebrew, were now, for the first time, systematically explained in Lati treatises. Alfonso made a collection of medieval poetry, with contemporary musical notations, called *Las Cantigas de Santa Maria*. Three manuscripts of this book are preserved, one in Madrid and two in the Escurial libraries. The poems are written in the Galician dialect. They are Andalusian poems of Muslim origin consisting of the Muwashshah and Zajal type. There were some famous Muslim musicians at the courts of the medieval kings of Castile and Aragon.

A number of musical instruments were introduced in the West by the Muslims *viz*; *al'Ud* (the lute); *Qitar* (guitar); *Rabab* (rebeck); *Naqqara* (naker); *Sunuj* (sonajas); *al-Duff* (tambourine); *Tanbur* (pandore); *Qasa* (kettledrum); *Tabl* (taber): *al-Nafir* (anafil); *Anfar* (fanfare); *al-Surnay* (aulcaye); *Kasa* (cymbal); *al-Shaqir* (eschaquil); *Zamr* (reed pipe) and *Qanum* (psaltery).

The word troubadour is derived from the Arabic word *taraba* i.e. to sing. The Spanish bagpipe *gaita* is the Arabic *al-ghayta*. The old Spanish instrument *Albogou* (Ar. *al-buq* and Latin *buccinum*) is played today in the Basque province.[1] The most important legacy in the field of music left to Europe by the Arabs is mensural music. Harmony and rhythm were also introduced by them.

1. Rodney Gallops: A Book of the Basques, p. 183.

School of Music

The famous school of fine arts and music founded by Ziryab at Cordova attracted students from all over the world who came to learn from great masters. Ziryab conducted the school with the help of his son Abd-al-Rahman who had inherited his talents.

Music developed on most scientific lines and the writings of Al-Kindi, Al-Sarakhsi (d. 899), Banu Musa, Thabit ibn Qurra (d. 901), Al-Farabi, (author of Grand Book of Music, Styles in Music and on the classification of Rhythm), Ibn Sina (author of the *Shifa* and *Najat* and an Introduction to the Art of Music), and Mohammad Ibn Zakariyya al-Razi (author of Assembling of the Sciences) were studied and followed. The great musical anthology *Kitabul-Aghani* of Abul Faraj al Isphahani was highly appreciated and studied by lovers of music and is reckoned as a mine of information regarding writers on the theory and science of music.

CHAPTER 19

Other Influences

Until fairly recently the Spanish language retained many of the Arabic words pertaining to clothes. Although the type of fine Arab silk has been changed to a heavy one used now, there is still a great similarity between the two even after the lapse of about 600 years. The vocabulary of hair dress, dress, footwear, brass utensils and jewellery is almost all Arabic.

The vast quantity of objects like plates, caskets, trays, cups, hand-warmers, incense-burners, ink-wells and pitchers, whose bronze surface was embellished with elegant decorations, engraved and often studded with copper, silver and gold produced by Oriental workshops in Iraq, Syria, Iran and Egypt, aroused keen amazement in the West. Benvenuto Cellini, the great goldsmith and sculptor of the Renaissance (1500-1571), did not overlook such work and spoke of it in his Memoirs. The degree to which the fame of these Muslim artists in metal spread in Italy is shown by the fact that the techniques they used are still known as *Damishqi* or *Ajami*—a clear reference to the Syrian and Persian workshops. The Muslim works of art and fine handicrafts were in great demand and fetched high prices in Italy and Venice up to the 16th century. Some of the immortal names of those masters of art who came to Venice are Mahmud-al-Kurdi, Zainuddin Omar, Kasim, Habibullah-ibn-Ali Baharjani and Alauddin Birjandi.

Mention may be made of the city of Lucca in Tuscany which became the centre of fine silk and quality brocades imported from Muslim countries

keeping alive the names of Oriental origin. Apart from the common taffeta, Italian mercantile books of the Middle Ages and the Renaissance refer to fabrics from Antioch, Cammocca or Comocato (Persian: *kamkhwab*), Siglaton (Persian: *saqallat*), Ghella silk (Ghilan) and Masandroni silk (Mazanderani). Their variety and excellence not only drew the attention of the nobles and princes but even poet like Dante admired their beauty and mentioned their original Arabic names in his *Divine Comedia* (Inf XVII, 13-48). A first-rate centre for the manufacture of fabrics was the royal Norman Tiraz in Palermo. After the dispersal of the Sicilian Muslims some of them migrated to Lucca, Amalfi, then to Genoa, Florence and Venice. The latter, moreover, was in direct contact with the Orient.[1]

.1 Prof. Alexandro Bausani: "Islamic Influence on Italian Culture", Pakistan Quarterly, Karachi, Summer, 1966.

CHAPTER 20

Development of Agriculture

The Arabs devoted their utmost energy to the development of agriculture and excelled their predecessors in this field. The Spanish Muslims understood the soil and the resources of their country better than any nation. Their system is reckoned as the most complex, the most scientific and the most perfect ever devised by the ingenuity of man. Its principles were derived from the plains of Mesopotamia and from the valley of the Nile where the cultivation of the earth had been carried to a state of extraordinary excellence.

The enlightened policy followed by the rulers was productive of immense advantage to every branch of agriculture. Highly talented botanists were sent by the Government to the fertile regiosu of Egypt, Mesopotamia and Indo-Pakistan sub-continent to select seeds of useful plants and fruits for experimental cultivation in the royal palaces.

Hydraulic System

Great encouragement and patronage were given to the tillers of the soil for the improvement of production. This incentive resulted in devotion to agricultural profession and brought a vast area of arid land under cultivation. Barren valleys were transformed into flourishing orchards of olives, oranges, figs and pomegranates.[1] Rocky slopes were covered with verdant terraces, where marshes existed, the rich lands they concealed were drained, reclaimed and placed under

1. Encyclopaedia of Islam, Vol. I, p. 492.

thorough cultivation. The Arab engineers introduced excellent hydraulic system—streams from mountains, artificial lakes, the reservoir, the wells, the sluices, the tunnel, the siphons, aqueducts and canals. They improved and extended the irrigation system of Egypt. They appropriated the Persian wheel, which with the rows of jars on its periphery, and propelled by cattle, served as a pump; or driven by the rapid current of streams, distributed the waters of the latter through lands of higher level. Fields were surveyed and grades ascertained by means of the astrolabe. The public works constructed for irrigation purposes were on a gigantic scale. The artificial basin near Alicante, elliptical in shape, is three miles in circumference and 50 feet deep. The aqueduct at Manesis in Valencia, is 720 feet long and is supported by 28 arches. The principle of siphon was utilised to a remarkable degree in the Moorish hydraulic system. The length of the curve in the great siphon at Almanzora is 750 feet, the diameter is 6 feet and it passes 90 feet under the bed of a mountain stream. The subterranean aqueduct at Maravilla, which waters the plain of Urgel, is a mile long and 30 feet in diameter. All these underground conduits are cut through the solid rock.

Tribunal of water

The irrigation system of the Caliphate was governed by a peculiar code of laws. The strictest economy was enforced. All waste was forbidden. The sluices were opened at certain times, the quantity furnished being accurately graduated according to the requirements of the cultivator. Under the special care of the Government a vigilant police patrolled the canals and guarded the reservoirs of every district. There was "The Tribunal of Water" to decide the cases on every Thursday. Each party stated his own case. The accused conducted his own defence.

Fertilisation

The same care and economy were observed in fertilising the soil. The land was divided into small tracts and for that reason was much more thoroughly tilled. Manure and dust were collected from the highways.

The contents of sewers and vaults were preserved, desiccated and mingled with less powerful substances. Ashes, the burned and pulverized seeds of fruits, the blood and bones of slaughtered animals, all played an important part in the productiveness of the soil. Besides improved processes of manuring, the Arabs invented an instrument called *marhifal* for levelling the earth.[1]

The Arabs preserved manures carefully in stores and reservoirs in order to prevent evaporation or leakage. Every substance available for the fertilization of crops was preserved. The vegetable products of distant countries of the world—the grains of Asia, the nuts and berries of Europe, the luscious fruits of the African coast—were imported into Spain.

The Muslims of Andalusia were fully conversant with the circulation of the sap, with the difference of sex in plants, with the technique of artificial fecundation. They adopted eight well-defined methods of grafting, and the harmful effects of the sun were obviated by the use of a perforated vessel, from which water fell in drops on the graft. They were fully aware of the treatment of the diseases of all the known species of the vegetable kingdom and preserved fruits for an indefinite period. They banished noxious insects and expelled poisonous gases from wells and excavations.

S. P. Scott rightly remarks, "The great work of Abu Zakariya ibn Mohammad Ibn-al-Awwam of

1. Ibn 'Awwam's Urdu translation by Syed Hashim Nadvi (Ma'arif Press, Azamgarh, India).

Seville, a vast monument of industry and erudition embracing every conceivable branch of the subject, shows to what extra-ordinary perfection the science of agriculture had been carried in the 12th century by the Spanish Muslims. It describes the breeding and care of every species of domestic animals, their qualities, their relative excellence, their defects, their habits and their diseases. It teaches different methods of cooking and the preparation of various confections, jellies, syrups and sweetmeats of every description".[1]

Agronomy

Prof. Hitti comments: "In the field of natural history, especially botany pure and applied, as in that of astronomy and mathematics, the Western Muslims enriched the world by their researches. They made correct observations on sexual differences between such plants as palms and hemps, and classified plants into those that grow from cuttings, those that grow from seed and those they thought grow spontaneously. A treatise on agriculture by Ibn-al-Awwam of Seville—towards the end of the twelfth century—is not only the most important Islamic, but the outstanding medieval work on the subject. Derived partly from earlier Greek and Arabic sources and partly from the experience of Moslem husbandmen in Spain, this book treats of 585 plants and explains the cultivation of more than fifty fruit trees. It presents new observations on grafting and the properties of soil and manure and discusses the symptoms of several diseases of trees and vines, suggesting methods of cure".[2]

Botanical Gardens

S. P. Scott writes: "To facilitate the investigation of the natural historian, there were numerous zoological collections, where the habits and characteristics of animals and birds of every description could be observed

1. History of the Moorish Empire, Vol. III, Chapter XXX.
2. A ShortHistory of the Arabs, p. 140.

and noted for the present entertainment and future profit of mankind. The royal botanical gardens contained an endless variety of plants, both indigenous and exotic."

Prof. Philip K. Hitti observes: "This agricultural development was one of the glories of Muslim Spain and one of the Arabs' lasting gifts to the land, for Spanish gardens have preserved to this day a "Moorish" character. One of the best known gardens is Generalife—a word which comes from the Arabic *Jannat al-'arif*, the "Inspectors' Paradise" a monument of the late thirteenth century whose villa was one of the outlying buildings of the Al-Hambra. This garden proverbial for its extensive shades, falling waters and soft breeze was terraced in the form of an amphitheatre and irrigated by streams which, after forming numerous cascades, lost themselves among the flowers, shrubs and trees represented today by a few gigantic cypresses and myrtles."[1]

Bertrand Russell thinks that "one of the best features of the Arab economy was agriculture, particularly the skilful use of irrigation, which they learnt from living where water is scarce. To this day Spanish agriculture pronts by Arab irrigation works."[2]

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CHAPTER 21

Industrial Arts and Quality Products

In the vast and diversified areas of the industrial and useful arts, the Hispano-Arab genius evolved and displayed no less grace and dexterity than in the outstanding and permanent creations of the architect. Texts from the Glorious Quran were carved upon the wooden stumps used by the baker. On garments and banners, on swords and knives, on vases and thimbles, on the massive bracelets of the rich, on the highly treasured amulets of the poor, were engraved or embroidered legends of pious origin and significance.

Treatment of Metals

Among the most significant branches of mechanical industry in which the Spanish Muslims excelled, was the treatment of metals. In the casting of bronze, they attained perfection. Not only statuary, but utensils for worship as well as for domestic use—vases, lamps, censers cups, knives and other articles—were produced by this scientific process.

In the Mosque of Cordova were suspended nearly 2,000 lamps, but none survived. The so-calledl amp of the Alhambra, which came in possession of those who took control of Oran, is supposed to have belonged to the mosque of that palace.

Arabic lamps were of different metals: gold, silver, copper or bronze. They contained two or more lights, placed one above the other, their rays being tempered by a polygonal screen. From the base usually hung four spheres of open work formed of lotus or palm

leaves and pomegranates and which exhibited verses of poetry or Quranic legends.

A few of the images which the Arab artists cast in bronze have survived. Among them are a lion and gazelle, which the researches of archaeology have assigned to one of the sumptuous palaces which adorned the suburbs of Cordova. Legends in Kufic lettering are inscribed upon them.

Kufic lettering was employed for stateliness or for masculine vigour; *naskhi* for an evenly smooth rhythm, and *nasta'liq* for a flowing and sometimes almost ethereal elegance.

Arms

In the manufacture of arms and armour the Spanish Muslims stood matchless. The arms forged upon the Tagus, whose waters it was supposed possessed some peculiar property that imparted an unrivalled temper to blades of steel, were famous even during the Visigothic domination. The swords of Seville enjoyed a high reputation for their superb craftsmanship. Upon their hilts and scabbard were lavished the finest efforts of the enamellers' and jewellers' art. Of most capricious forms were the guards, sometimes representing the heads of elephants or dragons, carved in ovals, globes and crosses; always inlaid with arabesques of the precious metals, representing floral designs and intricate geometrical figures with the omnipresent legend.

Engraved Jewels

The Muslim craftsmen understood the difficult art of encrusting metals with various crystals and artificial stones; their enamels were of every colour and of exceeding fineness; their goldsmiths had acquired such dexterity that they could make a single grain of that metal beaten into a sheet, cover a space of 56 sq. inches.

The engraving of the gems conformed to the general principles and characteristics of the arts as pursued by the Arabs. The process of the cameo does not seem to have been adopted by them but the word itself would seem to be derived from the Arabic *kamh* meaning "hump" or "projection". The name or monogram of the owner, a verse of the Quran, a wreath of entwined foliage, a complex design of geometric lines and curves—these were the sole objects upon which the talents of the artist might be legitimately exercised. Signets formed the greater number but amulets constituted no small part of the production of the Andalusian lapidary. The hand, symbolic of the fine cardinal precepts of Islam and the heart, were the favourite forms in which objects of this kind were carved.

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[1] History of Mankind, Vol. IV, Part II, p. 742.

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The fabrication of leathern hangings was from the very beginning one of the specialities of Cordovan Industry. Superb effects must have been produced by this curious tapestry, embossed and gilded, stamped and embroidered with graceful arabesques and suspended between rich and capricious cornices of stucco and dadoes blazing with a score of colours in mosaic. Goat skins formed the material.

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The fabrication of leathern hangings was from the very beginning one of the specialities of Cordovan Industry. Superb effects must have been produced by this curious tapestry, embossed and gilded, stamped and embroidered with graceful arabesques and suspended between rich and capricious cornices of stucco and dadoes blazing with a score of colours in mosaic. Goat skins formed the material.

Textile Fabrics

In the perfection of their textile fabrics, the Spanish Muslims demonstrated their infinite superiority to all contemporary world. In other States of Europe silk was the exclusive privilege of the royalty. After the 11th century, in Sicily and Spain this fabric was used by all classes, but elsewhere it was regarded as most valuable; the garments of men and women of the middle class of Granada were made of it, as were also the uniforms of the royal guards of Norman Palermo. The great Moslem banner preserved in the Abbey of La Hueglas near Burgos is an elegant example of the weaver's art. Upon the ground of crimson silk appear inscriptions, medallions and interlacing, interwoven in blue, white, green and yellow. In the patterns of the cloaks and robes of royal personages mingled

with brilliantly tinted arabesques, rich floral embroidery and verses from the Quran, appeared portraits of the owners, in the colours of nature, depicted with consummate skill. The tiraz or tunic of Hisham II preserved in the Museum of the Academy of History at Madrid, is the only specimen of this branch of textile fabrics. The dyes of the fabrics were permanent.

Persian weavers, under the patronage of the Safavid dynasty, produced brocades, damasks and other rich fabrics of the finest quality at Yezd, Kashan and Ispahan.[1]

Calligraphy

The art of calligraphy was so highly appreciated by the Arabs that it was styled the "Golden Profession", and in this, the Spanish Muslims achieved remarkable proficiency. It was developed, under the Caliphates of both the East and the West, and reached the climax of perfection. The skins they used had a ground of gold or silver or were dyed of various colours, scarlet, green, purple, blue and black: their lustre was so great that they reflected light like the polished surface of a mirror. Their inks were of different types. They were brilliant and durable. The manuscripts were enriched with illuminations. They included medallion, portraits, representations of men and animals delineated with astonishing skill, surpassing all their predecessors.

The contribution of Muslims to the development of commerce and industry is of far-reaching importance as they showed great interest in extending their patronage to different arts and handicrafts.

The ruling dynasties of the Abbasides of Baghdad, the Ummayads of Andalusia and the Emperors of Delhi established Imperial workshops where great emphasis was laid on the production of quality products. The famous historians Thatcher and Schwill in their book, "Europe in the Middle Age," have rightly remarked:

1. *Ibid.*, p. 742.

"In manufactures they surpassed the world in variety and beauty of design and perfection of workmanship. They worked in all metals—gold, silver, copper, bronze, iron and steel. In textile fabrics they have never been surpassed. They made glass and pottery of the finest quality. They knew the secrets of dyeing, and they manufactured paper. They had many processes of dressing leather, and their work was famous throughout Europe. They made tinctures, essences and syrups. They practised farming in a scientific way, and had good systems of irrigation. They knew the value of fertilizers, and adapted their crops to the quality of the ground. They excelled in horticulture, knowing how to graft and how to produce new varieties of fruits and flowers. They introduced into the West many trees and plants from the East, and wrote scientific treatises on farming."

Paper Industry

The Muslims introduced the manufacture of writing-paper in the Arab world which accelerated the progress and enlightenment in Europe. They produced paper in 974 A.D. in Baghdad. Later, the knowledge spread to Syria and other countries. In the middle of the 12th century, the technical know-how of paper manufacture was transmitted by the Muslims to Spain, Sicily, Italy and other parts of Europe from Morocco. The English word "ream" is derived through old French *Rayme* from Spanish *resma*, a loan word from Arabic *rizmah*, a bundle. After Spain, the art of paper-making was established in Italy, about 1270 A.D., also as a result of Muslim influence. France owed its first paper mills to Spain. From these countries the industry spread throughout Europe. A Secretary of Abd-al-Rahman used to write the official communications in his home and send them to a special office for reproduction—a form of printing (tab')—whence copies were distributed to the various government agents.[1]

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CHAPTER 22

Women's Contribution

In Andalusia women marched shoulder to shoulder with men and played a significant role in the cultural and intellectual advancement of the nation. There was hardly any phase of life where women did not make a mark—literature, science, poetry, medicine, art, philosophy as well as games. The exalted position occupied by women under the Arab domination in Andalusia gave them an influence and invested them with power. This peculiar social environment restrained the several instincts of the bard and encouraged the cultivation of noble and lofty sentiments. Many women attained eminent ranks in the scientific and literary profession. Many earned their living and some practised as advocates in the courts. They enjoyed a degree of freedom that was rare in the contemporary world.[1]

Ayesha, the daughter of Prince Ahmad of Cordova, excelled in rhyme and oratory, her speeches aroused the enthusiasm of the philosophers of Cordova. She was a calligraphist and used to scribe the Glorious Quran. Her addresses and speeches were of such literary excellence that they were prescribed as text books in the Cordova University for the study of literature. She possessed a very fine and rich library embracing all branches of human knowledge.

Walladeh (d. 1087), daughter of Al-Mustakafi, a princess of the Almohades, was renowned for her knowledge of poetry and rhetoric. Her conversation

1. Cambridge Medieval History, Vol. III, p. 437.

was remarkable for its depth and brilliance. According to Ibn Bashkwal, she participated in important literary discussions and seminars organized by cultural and literary societies, and her home in Cordova was the rendezvous of poets and savants. She lived for a long time and led a life of celibacy.[1]

Al-Ghusaniah and Safia, both of Seville, were distinguished for their poetical and oratorical ingenuity. Safia excelled all others in calligraphic art, "so that her penmanship was at once the object of admiration an example to be copied by the most skilful scribes."

The literary attainments of Maryam, the gifted daughter of Abu Yaqub al-Ansari of Seville, were remarkable. She also taught rhetoric, poetry and literature.

Umm-al-Sa'ad, daughter of Usam al-Himyari of Cordova, was a famous poetess and enjoyed high reputation for her knowledge of Hadith.

Labbanah of Cordova was well-versed in the exact sciences, and was appointed Secretary to Caliph Al-Hakam II. She was a versatile genius and had no compeer among her contemporaries.

Hassana al-Tamimiyeh, daughter of Abul Husain, and Ummul Ula, daughter of Yusuf were celebrated literary figures. Al-Aaruzziah of Valencia, was a great philologist, grammarian and an authority on prosody, and wrote commentaries on *al-Kamil* of *al-Mubarrad*.

Hafsah al-Rakuniah "renowned for her beauty, her talents, her nobility and her wealth" flourished under the Almohades. She shone as a star of the first magnitude in the firmament of literature and poetry. She recited a wonderful *Qasidah* before the ruler of Cordova, Abu Saeed Abdul Momin, which was highly acclaimed by the scholars and thinkers.

1. Al-Maqqari, Vol. II, pp. 536-539.

Ebadia was a calligraphist, poetess and linguist, and had a command over a number of languages and improvised excellent poems.

Hafsah, daughter of Hamdun, was an illustrious poetess and scholar of her age and Asma al-Aamariyah of Seville earned high reputation for her composition of refined poetry.

Ummul Hina, daughter of Qazi Abu Mohammed Abdul Haqq ibn Aatiyyeh, was both a poetess and a jurisconsult. Another scholar and poetess Hind Jaria also established her reputation in the literary circles.

Nazhun of Granada, daughter of Abu Bakr al-Ghassani, was an eloquent poetess, well-versed in history and literature. She possessed a wonderful memory and occupied a pre-eminent position in the society.

Itimad al-Ranukkyeh and Busina, the wife and daughter of Mu'tamid, the last king of Seville, also held high position among the contemporary scholars. Bahja, a native of Cordova, was renowned for her noble verses.

Zainab and Hamda were the daughters of Ziyad, the bookseller, and lived near Granada. Ibn al-Abbar in his *Tuhfat al-Qadim* writes, "They were both excellent poetesses, thoroughly versed in all branches of learning and sciences; they were beautiful, rich, amiable and modest. Their love for learning brought them into the company of scholars, with whom they mixed on perfect terms of equality with great composure and dignity, and nobody could accuse them of forgetting the rules of their sex".

Maria, the daughter of Abu Yaqub al-Faisali, has been called the Arabian Corinna; she also was eminent for her learning and scholarship.[1]

1. Ameer Ali, History of Saracens, p. 569.

S. P. Scott in his book "The Moorish Empire in Europe" says: "Under the Spanish Arabs, women enjoyed privileges which were denied to them in other countries. They participated in national and provincial contests for the palm of literary excellence. Many—proficient in poetry, philosophy, grammar and rhetoric—excited universal admiration by the scope and variety of their mental accomplishment. Some even became the political advisers of great sovereigns. During the time of Charles II of England only a few women could read and write, but 800 years before him women of Cordova had established an enviable reputation for their proficiency in all arts which contribute to the culture of the nations; for the skill which they exhibited in every department of scientific research, for their originality in poetical compositions."[1]

1. Volume III, pp. 656-57.

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CHAPTER 23

New Horizons of Science and Learning

According to John W. Cambell, the whole of Europe except Italy was in a state of barbarism. It was the civilisation of Islam which infused light into Europe.

Lane-Poole in his famous book "The Moors in Spain", remarks, "students flocked from France, Germany, England and every part of Europe to drink from the fountain of learning which flowed only in the city of Moors".

S. P. Scott in his monumental work "Moorish Empire in Europe" writes, "No achievement of ancient or modern time was perfected with such rapidity or produced such decided effect upon the intellectual progress of the human race as that of the Arabs".

About Islam's contribution to the modern world progress and western civilisation Oxford Junior Encyclopaedia remarks: "It is said that institutions created by the Arab Muslims were remarkable for their good sense and humanity and that justice was frequently well administered. Even the Jews and Christians so long as they paid taxes received the protection of the Islamic State. The modern world also owes a debt to Islam for keeping a live and fostering art and science through dark ages in the great centres of Arab civilisation at Baghdad, Cairo and Cordova".

Allama Mohammed Asad in his book "Islam at the Crossroads", referring to the new cultural impulses and ideas which the Arabs had been transmitting to the West for several centuries, comments: "What-

ever had been best in the culture of old Greece and the later Hellenistic period, the Arabs had revived in their learning and improved upon, in the centuries that followed the establishment of the early Islamic Empire. I do not say that the absorption of Hellenistic thought was an undisputed benefit to the Arabs, and the Muslims generally—because it was not. But for all the difficulties which this revived Hellenistic culture may have caused to the Muslims by introducing Aristotelian and Neo-Platonic Philosophy into Islamic theology and jurisprudence, it acted, through the Arabs, as an immense stimulus to Europe. The Middle Ages had laid waste Europe's productive forces. Sciences were stagnant, superstition reigned supreme. the social life was primitive and crude to an extent hardly conceivable today. At that point the cultural influence of the Islamic world—at first through the adventure of the Crusades in the East and the brilliant universities of Muslim Spain in the West, and later through the growing commercial relations established by the republics of Genoa and Venice—began to hammer at the bolted doors of European civilisation. Before the dazzled eyes of the European scholars and thinkers another civilisation appeared—refined, progressive, full of passionate life and in possession of cultural treasures which Europe had long ago lost and forgotten.

"What the Arabs had done was a far more than a mere revival of old Greece. They had created an entirely new scientific world of their own and developed until then unknown avenues of research and philosophy. All this they communicated through different channels to the western world; and it is not too much to say that the modern scientific age in which we are living at present was not inaugurated in the cities of Christian Europe, but in such Islamic centres as Damascus, Baghdad, Cairo, Cordova, Nishapur and Samarqand

"The effect of these influences on Europe was tremendous. With the approach of Islamic civilisation

a new intellectual light dawned on the sky of the west and infused it with fresh life and thirst for progress. It is no more than a just appreciation of its value that European historians term that period of regeneration, the Renaissance—that is, "re-birth". It was, in fact, a re-birth of Europe."

Ameer Ali estimating the achievements of the Arabs says: "The Saracenic race by its elastic genius as well as by its central position—with the priceless treasures of dying Greece and Rome on one side, and of Persia on the other, and India and China far away sleeping the sleep of ages—was pre-eminently fitted to become the teacher of mankind. Under the inspiring influence of the great Prophet, who gave them a code and a nationality, and assisted by their sovereigns, the Saracens caught up the lessons of wisdom from the East and the West, combined them with the teachings of the Master, and started from soldiers into scholars."

Humboldt says, "The Arabs were admirably situated to act the part of mediators, and to influence the nations from the Euphrates to the Guadalquivir and Mid-Africa. Their unexampled intellectual activity marks a distinct epoch in the history of the world."

Charles T. Gorham, writing about the achievements of the Muslims in his book "Christianity and Civilisation says: "In the eighth century the Moors conquered Spain, and, as if by magic, a splendid civilisation sprang into being. An extensive commerce and a general love for industry created a wealth that astounded the Christian world. Wise laws developed and regulated an ingenious system of agriculture. The Moors bred cattle, sheep and horses. Civilisation owes to them the culture of silk and introduction into Europe of rice, sugar, cotton and many fruits. They fostered the manufacture of textile fabrics, earthenware, iron, steel and leather. While Christians were slaughtering one another for the glory of God, the Spanish Moors were writing treatises on the principles

of trade and commerce. A Christian stricken by disease sought the aid of the nearest saint, and wanted a miracle; the Moors relied on the presumptions of a physician or the skill of a surgeon. Rome and Constantinople were asserting the flatness of the earth while the Spanish Arabs were using globes in their common schools. In practical science especially in astronomy, botany, optics surgery and medicine, their achievements were beyond imitation or even comprehension of the rest of Europe for hundreds of years. The study of Algebra and Mathematics was carefully cultivated by the Moors. They understood the weight of the atmosphere and the principes of hydrostatics, discovered the theory of the pendlulum, recognised gravity as force, and, at least partially, discovered the theory of the progressive development of animal organism. A school of poets arose in Spain who furnished the germs of poetry of Provence; the fiction writer and the historian were held in high esteem. Dictionaries, one of which was in sixty volumes, and encyclopaedias were completed. The palaces of the rulers were adorned with mosaics and tapestries and lighted by chandeliers, the courts were cooled by cascades; baths of marble were supplied with warm and cold water, according to the season. The scrupulous cleanliness of the Arab was as great an improvement on the verminous hair shirt of the Christian saint as the superb palace of the Caliph was upon the Chimneyless barn of the Christian King. In the great city of Cordova, a centre of learning and prosperity, the streets were paved and lighted centuries before London or Paris had imagined such luxuries."

George Sarton, the great historian of science has paid glowing tributes to Muslim scholars and their attainments: "The most valuable of all, the most original and the most pregnant works were written in Arabic. From the second half of the eighth to the end of the eleventh century, Arabic was the scientific and the progressive language of mankind. During that

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a new intellectual light dawned on the sky of the west and infused it with fresh life and thirst for progress. It is no more than a just appreciation of its value that European historians term that period of regeneration, the Renaissance—that is, "re-birth". It was, in fact, a re-birth of Europe."

Ameer Ali estimating the achievements of the Arabs says: "The Saracenic race by its elastic genius as well as by its central position—with the priceless treasures of dying Greece and Rome on one side, and of Persia on the other, and India and China far away sleeping the sleep of ages—was pre-eminently fitted to become the teacher of mankind. Under the inspiring influence of the great Prophet, who gave them a code and a nationality, and assisted by their sovereigns, the Saracens caught up the lessons of wisdom from the East and the West, combined them with the teachings of the Master, and started from soldiers into scholars."

Humboldt says, "The Arabs were admirably situated to act the part of mediators, and to influence the nations from the Euphrates to the Guadalquivir and Mid-Africa. Their unexampled intellectual activity marks a distinct epoch in the history of the world."

Charles T. Gorham, writing about the achievements of the Muslims in his book "Christianity and Civilisation says: "In the eighth century the Moors conquered Spain, and, as if by magic, a splendid civilisation sprang into being. An extensive commerce and a general love for industry created a wealth that astounded the Christian world. Wise laws developed and regulated an ingenious system of agriculture. The Moors bred cattle, sheep and horses. Civilisation owes to them the culture of silk and introduction into Europe of rice, sugar, cotton and many fruits. They fostered the manufacture of textile fabrics, earthenware, iron, steel and leather. While Christians were slaughtering one another for the glory of God, the Spanish Moors were writing treatises on the principles

of trade and commerce. A Christian stricken by disease sought the aid of the nearest saint, and wanted a miracle; the Moors relied on the presumptions of a physician or the skill of a surgeon. Rome and Constantinople were asserting the flatness of the earth while the Spanish Arabs were using globes in their common schools. In practical science especially in astronomy, botany, optics surgery and medicine, their achievements were beyond imitation or even comprehension of the rest of Europe for hundreds of years. The study of Algebra and Mathematics was carefully cultivated by the Moors. They understood the weight of the atmosphere and the principes of hydrostatics, discovered the theory of the pendlulum, recognised gravity as force, and, at least partially, discovered the theory of the progressive development of animal organism. A school of poets arose in Spain who furnished the germs of poetry of Provence; the fiction writer and the historian were held in high esteem. Dictionaries, one of which was in sixty volumes, and encyclopaedias were completed. The palaces of the rulers were adorned with mosaics and tapestries and lighted by chandeliers, the courts were cooled by cascades; baths of marble were supplied with warm and cold water, according to the season. The scrupulous cleanliness of the Arab was as great an improvement on the verminous hair shirt of the Christian saint as the superb palace of the Caliph was upon the Chimneyless barn of the Christian King. In the great city of Cordova, a centre of learning and prosperity, the streets were paved and lighted centuries before London or Paris had imagined such luxuries."

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period anyone wishing to be well-informed and up-to-date, had to study Arabic. It will suffice here to evoke a few glorious names without contemporary equivalents in the West: Jabir-ibn Hayyan, Al-Kindi, Al-Khwarizmi, Al-Farghani, Al-Razi, Thabit ibn Qurra, Al-Battani, Hunain ibn Ishaq, Al-Farabi, Ibrahim ibn Sinan, Al-Masudi, Al-Tabari, Abul Wafa, Ali ibn Abbas, Abul Qasim, Ibn-al-Jazzar, Al-Biruni, Ibn Sina, Ibn Yunus, Al-Karkhi, Ibn al-Hatham, Ali ibn Isa, Al-Ghazzali, Al-Zarqali, Omar Khayyam—a magnificent array of names which it would not be difficult to extend. If anyone tells you that the Middle Ages were scientifically sterile, just quote these men to him. All these scientists flourished within a relatively short period between 750 and 1100 A.D."

E. A. W. Budge, in Chronography (London, 1932) says: "And there arose among the Arabs, philosophers, mathematicians and physicians, who surpassed the ancient sages in the exactness of their knowledge. The only foundations on which they set up their buildings were Greek houses; the wisdom—buildings which they erected were great by reason of their highly polished diction, and their greatly skilled researches."

Charles Homer Haskins, in his book "Studies in the History of Medieval Science" thinks that the most active work in translation from Arabic to Latin went on in Spain, where a succession of translators, busy with many subjects, can be traced from about 1125 to about 1280. "To them we owe texts of Aristotle, Ptolemy, Euclid and the Greek physician, Avicenna, Averroes, and the Arabic astronomers and mathematicians, a great mass of astrology, apparently also a certain amount of alchemy."

"Next to Spain in importance", writes Sir William Cecil Dampier, in his book "A History of Science", "were Southern Italy and Sicily, whence came translations both from Arabic and from Greek, made possible

by the presence of resident Arabs and Greeks, and by diplomatic and commercial relations with Constantinople. From this source were obtained medical works, a geographical treatise and map, and Ptolemy's Optics. Of scattered or unknown origin are translations of Aristotle's 'On Animals', 'Metaphysics' and 'Physics', and other less important works which appeared in the West from 1200 onwards.

The current language of scientific literature was Arabic, and translations from the Arabic, even of Greek authors, were highly valued. The Arabic-speaking races and the Jews living among them had, at this time, a real interest in science, and it was by contact with Muhammadan countries that medieval Europe passed from its earlier outlook to a more rationalist habit of mind. (p. 83)

H. G. Wells has rightly remarked: "And a century or so in advance of the West, there grew up in the Muslim world at a number of centres, at Basra, at Kufa, at Baghdad and Cairo, and at Cordoba, out of what were at first religious schools dependent upon mosques, a series of great universities. The light of these universities shone far beyond the Muslim world, and drew students to them from east and west. At Cordoba in particular there were great numbers of Christian students, and the influence of Arab philosophy coming by way of Spain upon the universities of Paris, Oxford and north Italy, and upon Western European thought generally, was very considerable indeed. The name of Averroes (Ibn Rushd) of Cordoba (1126-1198) stands out as that of the culminating influence of Arab philosophy upon European thought. He developed the teachings of Aristotle upon lines that made a sharp division between religious and scientific truth, and so prepared the way for the liberation of scientific research from the theological dogmatism that restrained it both under Christianity and under Islam. Another great name is that of

Avicenna (Ibn Sina), the Prince of Physicians (980-1037), who was born at the other end of the Arabic world at Bokhara and who travelled in Khorasan... The book-copying industry flourished at Alexandria, Damascus, Cairo and Baghdad, and about the year 970 A.D., there were twenty-seven free schools open in Cordoba for the education of the poor".[1]

1. The Outline of History, p. 926, Cassell & Co., London, 1934.

CHAPTER 24

Decline of Muslim Ascendancy

From the advent of Islam in the seventh century to the end of the 17th, not to descend later, Islam was animated by a scientific and literary spirit equal in vigour and influence to that which animates Europe and America of our own day. It led the Muslims forward on the march of progress and enabled them to achieve a high degree of political, economic, social and intellectual development. Since the eruption of the Goths and the Vandals, the progress of Europe has been on a continuous scale. No such calamity as has afflicted Asia, in the person of Chingiz Khan and Hulaku has befallen Christians since Attila's retreat from France. Her wars, cruel and bitter, fierce and inhuman, have been waged on equal terms of humanity or inhumanity. Roman Catholics and Protestants have burnt each other but Europe has never witnessed, since the wholesale slaughter of the Spanish Moors, the terrible massacre committed by the Tartars in all the centres of Muslim civilisation and culture, in which fell the most talented and learned scholars who formed the backbone of the nation.

Who can forget the sack of Baghdad and other cities in 1258 and the atrocities perpetrated by the savages. For three days the streets ran with blood, and the water of the Tigris was dyed red for miles along its course. The horrors of rapine, slaughter and outraged humanity lasted for six weeks. The palaces, mosques and mausoleums were destroyed by fire or levelled to the ground for their golden domes. The patients in the hospitals and the students and

professors in the colleges were put to sword. In the mausoleums the mortal remains of the Sheikhs and pious Imams, and in the academies the immortal works of great and learned men, were consumed to ashes; books were thrown into the fire, or, were dumped in the waters of the Tigris. The accumulated treasures of five centuries were thus lost for ever to humanity. The flower of the nation was completely destroyed.

Prof. P. K. Hitti has given a very vivid description of the havoc wrought by the Mongols. He says: "In 1216 Chingiz Khan, with an appalling swarm of some 60,000 Mongolian barbarians, riding fleet horses and armed with strange bows, appeared to spread havoc and destruction. Before them the cultural centres of eastern Islam were practically wiped out of existence, leaving bare deserts or shapeless ruins where formerly had stood stately palaces and libraries. A crimson streak marked their trail. Out of the population of 100,000, Herat was left 40,000. The mosques of Bokhara, famed for piety and learning, served as stables for Mongolian horses. Many of the inhabitants of Samarqand and Balkh were either butchered or carried into captivity. Khwarizm was utterly devastated.

"The second wave of Mongol hordes was on. It swept before it all those petty princedoms which were striving to grow on the ruins of the Empire. In January 1258, the Mangonels of Hulaqu were in effective operation against the walls of the capital (Baghdad). Soon a breach was effected in one of the towers. The Vizier, accompanied by the Nestorian primate—Hulaqu had a christian wife—appeared to ask for terms. But Hulaqu refused to receive them.... By the tenth of February his hordes had swarmed into city and the unfortunate Caliph with his 300 officials rushed to offer an unconditional surrender. Ten

1. Spirit of Islam, p. 402.

days later they were all put to death. The city itself was given over to plunder and flames; the majority of its population, including the family of the Caliph, were wiped out of existence..... For the first time in its history the Moslem world was left without a Caliph whose name could be cited in the Friday prayers.[1]

But, to explain the stagnation of the Muslims in the present day, it is necessary to glance back for a moment at the events that transpired in Spain, in Africa and Asia between the 12th and 17th centuries. In Spain Christians destroyed the intellectual life of the people. The Muslims had turned Spain into a garden; the Christians converted it into a desert. The Muslims had covered the land with colleges and schools; the Christians transformed them into Churches for the worship of saints and images. The literary and scientific treasures amassed by the Muslim sovereigns were consigned to the flames. The Muslim men, women and children were ruthlessly butchered or burnt at the stake; the few who were spared were reduced to slavery. Those who fled were thrown on the shores of Africa helpless beggars. It would take the combined charity of Jesus and Mohammad to make Islam forget or forgive the terrible wrongs inflicted by the Christians of Spain upon the Andalusian Muslims. But the punishment was not long in coming. Before the world was a century old, Spain's fire had sunk into a heap of ashes.[2]

"As early as 1501, a royal decree was issued declaring that all Muslims in Castile and Leon should either recant or leave Spain, but evidently it was not strictly applied. In 1526, the Muslims of Aragon were confronted with the same alternatives. In 1556, Philip II promulgated a law requiring the remaining Muslims to abandon at once their language, worship, institutions and manner of life. He even ordered the destruction

1. Hitti, A Short History of Arabs, pp. 165-66.
2. Spirit of Islam, pp. 399-400.

of the Spanish baths as a relic of infidelity..... The final order of expulsion was signed by Philip III in 1609, resulting in the forcible deportation *en masse* of practically all Muslims on Spanish soil. Some half a million are said to have suffered this fate, having been forced to embark for the shores of Africa or to take ship to more distant lands of Islam.... Between the fall of Granada and the first decade of the 17th century, it is estimated that about three million Muslims were banished or executed.[1]

In Western Africa, the triumph of Patristicism under the third Almohade sovereign, and the uprise of Berber fanaticism turned back the tide of progress, arrested the civilisation of centuries, and converted the seats of learning and arts into centres of bigotry and ignorance. The settlement of Corsairs on the Barbary coast and the anarchy which prevailed in Egypt under the Mamelukes, discouraged the cultivation of peaceful knowledge. In Asia, the decadence of the Timuride dynasty, the eruption of the wild and fanatical Uzbegs, and the establishment of their power in the capital of Timur destroyed the intellectual vitality of the people. In Persia, under the Safavids, literature and science had begun to breathe once more, but this renaissance was only temporary, and with the irruption of the barbarous Ghihzais the renovated life of Iran came to an end. A deathlike gloom settled upon Central Asia.

Other causes are not far to seek. By 1258, the Arabs lost their hegemony for ever and the period of the glory of the Caliphate closed.

Prof. Bernard Lewis gives a critical analysis of the signs of decay: "By the 11th century, Islamic State and society show many signs of internal decay. The symptoms of decadence are discernible even earlier: in the fragmentation of the Empire into a series of autonomous regional sovereignties; the decline of the

1. A Short History of Arabs, pp. 152-153.

power and prestige of the Caliphs even in their own capital, where they fell under the rules of dynasties of alien and heretical Mayors of the Palace; the collapse of the whole political and administrative structure elaborated by the Islamic Empire of foundations inherited from Byzantium and Sassanid Iran. With the real power of the Caliphs and of the Islamic State was lost to a series of military autocrats ruling through their troops, even the religious status of the Caliph as head of orthodox Islam was dragged to the lowest level, as great sections of the populations followed heretical sects.

"In economic life signs of decay appear somewhat later. The Buwayhids restored for a while the order and prosperity of the central provinces. The Fatimids inaugurated the age of greatest prosperity in medieval Egyptian history. But the signs of economic decay were increasing in the east and later also in Egypt. The once profitable trade with China dwindled and died away, partly for reasons arising out of internal conditions in that country. Trade with Russia and the Baltic countries, which had flourished during the eighth, ninth and tenth centuries, diminished and disappeared during the eleventh, while the growing shortage of precious metals helped to stifle commerce even inside the Empire and accelerated the development of feudal type of economy.

"Grants of land and revenues, of various kinds, had been known since the beginning of the Islamic Empire. By the tenth century, however, an entirely new kind of grant, differing in several important respects from the earlier forms, makes its appearance. The farming out of state revenues had already become a common practice, and soon the government found a precarious remedy for its shortage of funds by leasing out state revenues to officers and high officials in lieu of pay.

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"Before long, provincial governors were given the tax-farms of the provinces they governed, with the obligation only of remitting an agreed sum to the central treasury after having met the cost of the provincial forces and administration. These farm-governors thus became, in effect, vassals or tenants-in-chief of the central power. Soon they became the real rulers of the Empire the more so when grants and governorships became the prerogative of the military caste, who alone had the strength and authority needed to enforce obedience."[1]

A number of social and moral forces also crept in and sapped the solid foundation of the Empire. The blood of the conquering race became diluted with that of the conquered, undermining the dominant position and superior qualities of the Muslims. With the decadence of the national life of the Arabs, their vigour, virility, stamina and morale declined. The institution of the harem, luxurious life, petty social jealousies and intrigues, and such other weakening forces totally demolished the vitality of the family life. They forgot their sense of duty and responsibility to God and man.

But the greatest and by far the most important of all causes, direct or indirect, was the scientific and technological revolution that took place in the West after the Renaissance but which was, unfortunately, misunderstood by the Muslims at the time. This revolution led to immense power over the forces of nature whose importance the Muslims failed to realise.

Until soon after the Renaissance, both East and West looked for their philosophy of nature for, what may be called, the classic interpretation of the facts of the universe. This natural philosophy was the foundation of both Eastern and Western nations on which they based their technology and their means of production until about 300 years ago. Then the West, under the influence of certain men of genius such as Leonardo da Vinci, Descartes, Galileo.

1. Cambridge Medieval History, Vol. IV, pp. 649-650.

Copernicus and Bacon and a good many others, began to question the truth of Greco-Arabian explanations and finally broke away from the classical traditions and turned directly to nature. Observation of natural phenomena and questions by experiments became the foundations and guiding stars of the mind and thought of the West.

Unfortunately, at this critical time more and more thought and concentration were given in the Muslim East to further studies of the classical discoveries of the past. A full stop was thus put to fresh inquiry.

The "Allama" theory of knowledge in which the past was given complete wisdom and the future was to follow rather than to go forward, put a stop to what was most important for political, economic and indeed the cultural life of the Muslims.

Dr. Mohammed Iqbal, the poet-philosopher, summing up the continuity of intellectual life between Muslim culture and modern knowledge, says: "The political fall of Islam in Europe unfortunately took place, roughly speaking, at a moment when Muslim thinkers began to see the futility of deductive science and were fairly on the way to building inductive knowledge. It was practically at this time that Europe took up the task of research and discovery. Intellectual activity in the world of Islam practically ceased from this time and Europe began to reap the fruits of the labours of Muslim thinkers. The Humanist movement in Europe was due to a large extent to the force set free by Muslim thought. It is not at all an exaggeration to say that the fruits of modern European Humanism in the shape of modern science and philosophy are in many ways only a further development of Muslim culture. Neither the European nor the Musalman of today realises this important fact because the extant work of Muslim thinkers still lies scattered and unpublished in the libraries of Europe, Asia and Africa. The ignorance of the

Musalmans of today is so great that they consider thoroughly anti-Islamic what has in the main arisen out of the bosom of their own culture. If, for instance, a Muslim savant knew that something like the theory of Einstein was seriously discussed in the scientific circles of Islam (Abul Ma'ali quoted by Averroes) the present theory of Einstein would appear to him less outlandish. Again his antipathy to modern Inductive logic would be very much diminished if he knew that the whole system of modern logic started from Razi's well-known objection to the deductive logic of Aristotle.[1]

Both East and West are agreed that the Greco-Arab period produced some of the greatest intellectual giants of human race.

But while the Muslims were satisfied to look at the work through the eyes of their giants, the West insisted on more and more pygmies sitting one over the other on the top of the giant's shoulders till their accumulated height was infinitely greater than that of the original giant on whom they had built up their foundation.

"It is surprising to note that not a single scientist of any repute existed in the entire Muslim world from the beginning of the eighteenth century. On the other hand, what one finds in this period is a condemnation of modern scientific knowledge because of its supposedly anti-religious tendencies. While the Muslims gloried in the achievements of the past, they neglected the new weapons of inquiry which the West had discovered with the progress of science and technology. The result was a terrible catastrophe. Whereas the other nations progressed, imbued as they were with modern spirit of inquiry, the Muslims frittered away their energies in fruitless controversies of a theological and trans-empirical nature. Instead of imbibing the

1. Dr. Iqbal's letter to Sahibzada Aftab Ahmad Khan, Iqbal Review, Karachi, October 1962, pp. 1-2.

results of modern science and conducting inductive inquiries, what they did was to question the compatibility of modern knowledge with their mistaken views of religion and to pooh-pooh it because of its materialistic import.

"Blind imitation of the past became the hallmark of the Muslims. The Muslims of this period did not follow the great principle of movement in the social structure of Islam, technically called *Ijtihad*, and blindly accepted the interpretations of the past. The Muslims miserably lacked the courage to think for themselves and consequently flew to the past for shelter. But the inevitable result of mental procrastination was the creation of a society extremely rigid and immobile in outlook and intellectual framework."[1]

Dr. Edward Sachau's criticism that, "But for al-Ash'ari and al-Ghazzali the Arabs might have been a nation of Galileos, Keplers and Newton"[2], seems to be too sweeping a remark. Al-Ghazzali's monumental work, *Ihyal-Ulum-al-Din* and other writings were widely studied by the Muslims, Jews and Christians and contributed to the spread of Scholasticism in Asia and Europe, as may be judged by their influence on Thomas Aquinas and even Blaise Pascal.[3]

But Ameer Ali thinks that the reactionary character of the influence exercised by Abul Hasan Ali al-Asha'ri and Ahmad al-Ghazzali can hardly be over-estimated. By their denunciation of science and philosophy, by their exhortations that besides theology and law no other knowledge was worth acquiring, they did more to stop the progress of the Muslim

1. History of Muslim Philosophy, Vol. II, pp. 1428-29.
2. The Chronology of Ancient Nations (Introduction, London, 1879).
3. Abdur Rahman Khan, Muslim Contribution to Science and Culture, p. 44 (Lahore, 1946).

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world than most other Muslim scholasts. And upto this day their example is held forth as a reason for ignorance and stagnation.

The baneful effect of the degenerate type of mysticism was not confined simply to the indictment of intellectual inquiry. It had far-reaching consequences, for as Iqbal says, "The emphasis that it laid on the distinction of *Zahir* and *Batin* (appearance and reality) created an attitude of indifference to all that applies to Appearance and not to Reality. The spirit of total other worldliness obscured men's vision of a very important aspect of Islam as a social polity".[2]

It cannot be gainsaid that the cult of saint worship, pre-deterministic and fatalistic ideas of Sufism became an essential part of the creed of the masses. The socio-economic structure of Islam was shattered to pieces, and the spirit of original thinking, critical analysis, keen observation and experimental method disappeared. In addition, the Muslims also lost the noble qualities of character, integrity and sense of individual and national duty. There was a gradual decline of national education, therefore, the percentage of literacy dwindled to a minimum in all the Muslim countries, including Iran, Turkey, Mughal India, Malaya and East Indies (Indonesia).

On the other hand, the West made tremendous progress in scientific and technological education, in trade and commerce. They developed their naval power, military science, more effective techniques, strategy and diplomacy and ventured on the high seas with the spirit of conquest and expansion of empire.

Ibn Khaldun's views on the decline of civilizations are based on the all-embracing factor of '*asbiyah* which in his terminology means 'solidarity', 'group feeling', 'group consciousness'—the group to which an

1. Spirit of Islam, pp. 486-87.
2. Iqbal's Six Lectures, p. 150.

individual feels most closely attached to his clan or tribe, the people with whom he shares a common descent.[1]

Ibn Khaldun feels that this group-feeling can be sustained, strengthened and directed into proper channels by religion. "When hearts succumb to false desires and are inclined towards the world, mutual jealousy and widespread differences arise. But when they are turned towards the truth and reject whatever is false, and advance towards God, they become one in outlook. Jealousy disappears; there are few differences, mutual cooperation and support flourish. As a result, the extent of the state widens, and the dynasty grows.

"When people who have religious colouring come to have the right insight into their affairs nothing can withstand them because their outlook is one and their object one of common accord. They are willing to die for their objectives. On the other hand, the members of the group they attack may be many times as numerous as they. But their purposes differ, inasmuch as they are false purposes, and the people of the worldly group come to abandon each other since they are afraid of death. They are overpowered and quickly wiped out as a result of luxury etc. existing among them."

Ibn Khaldun observes that a dynasty-state passes through five stages and encounters new conditions in each. "The first stage is that of success, the overthrow of all opposition and the appropriation of authority from the previous state. In this stage, the ruler serves as a model to his people. He collects taxes, defends property, and provides military protection.

"The second stage is the one in which the ruler gains complete control over the people and claims authority all for himself.

1. Franz Rosenthal, Ibn Khaldun, An Introduction to History, Boillngen Foundation Inc., New York, 1967.

"Third stage is one of leisure and tranquillity in which fruits of authority are enjoyed. They include erecting large buildings, spacious cities, lofty monuments, regulating income and expenses, planning etc.

"Fourth stage is of contentment and peacefulness. Ruler imitates ways of predecessors and thinks that to depart from tradition would mean the destruction of his power.

"The fifth stage is of waste and squandering. In this stage, the ruler wastes on pleasures and amusements the treasures accumulated by his ancestors, through excessive generosity to his inner circle. Also, he acquires bad, low-class followers to whom he entrusts the most important matters of state, which they are not qualified to handle by themselves. Thus people come to hate him and conspire to refuse support to him. In this stage, the dynasty is seized by senility and the chronic disease from which it can hardly rid itself, for which it can find no cure, and eventually it is destroyed".

He adds: "Among the things that corrupt sedentary culture is the disposition towards pleasure and indulgence in them because of the great luxury that prevails. It leads to the diversification of the desires of the belly for pleasureable food and drink. This is followed by diversification of the pleasures of sex through various ways.

Another major cause of decline of civilizations, according to Ibn Khaldun, is 'injustice'. He observes that "injustice ruins civilizations and the ruin of civilizations has, as its consequence, complete destruction of dynasty-state."

He defines injustice in these words: "Whoever takes someone's property or uses him for forced labour, presses an unjustified claim against him, or imposes upon him a duty not required by the religious law, does an injustice to that particular person.

"People who collect unjustified taxes commit an injustice. Those who infringe on property rights commit an injustice. Those who take away property commit an injustice. Those who deny people their rights commit an injustice. Civilization is ruined when people have lost all incentives".[1]

Shah Waliullah, one of the most outstanding scholars and dynamic intellectual leaders of the 18th century made a deep study of Islam and diagnosed the main causes of Muslim decline as: (a) differences over *fiqah* and its interpretation; (b) unfair and iniquitous judgements by Muslim jurists (c) giving up of *Shariah* by Muslim Society, (d) blind *taqlid* of predecessors and no *Ijtehad*, (e) luxurious life of rulers, sovereigns and nobility; (f) economic inequalities between different classes; (g) lack of unity of thought and action and the absence of spirit of co-operation.

In his scholarly book *Hujjatullah al-Baligha* he pleaded for creative thinking, cohesiveness and elasticity in Muslim Society through a deep study and thorough understanding of the Quran and the Hadith.

J. J. Saunders has rightly observed:

"Yet this brilliant (Muslim) culture which shone so brightly in contrast to the darkness of the Latin West and the stagnation of Byzantian began to fade from the 13th century A.D. The nations of Western Europe once sunk in barbarism caught up and overtook the peoples of Islam. How did this come about? The question has hardly yet received a complete and satisfactory answer; but some tentative suggestions may be offered:

1. "Collapse of Pan-Islamica after about 1050 A.D. End of long peace marked waves of nomadic invasion; the Banu Hilal in North Africa, the Turkoman and Saljuks in Western Asia and the mighty Mongol devastations which inflicted irreparable damage

1. An Introduction to History of the World.

on so many Muslim lands between 1220-1260 A.D. The Christian West escaped all this, since after the Northerns and Magyars had been tamed and converted around 1000 A.D., it had never to fear from barbarian attacks; the Mongols never got farther west than Hungary and Silesia.

2. "The decay of city life and economic prosperity. The Arabic civilization was essentially urban and its material basis was the vigorous commercial activity which once covered an area extending as far as Scandinavia, China, Sudan and Nigeria. Nomad raids diminished this activity. From 12th century onwards volume of international trade contracted, urban wealth declined and social and economic conditions underwent drastic changes in the Muslim world. *Jagirdari* system, *ikta*, came into existence.

3. "Loss of linguistic and cultural unity. In the days of its widest expansion, Arabic was written and understood wherever Islam prevailed, but its intellectual monopoly was threatened and finally broken by the revival of Persian in the lands east of the Tigris. Turks carried Persian with them to Asia and eastwards into northern India; they set little store by Arabic. Mongol invasion dealt a fatal blow to Arabic in eastern Islam; never again was Muslim world to be dominated by a single language.

4. "After the Mongol invasion, during the Turk domination, there was a shift in the Muslim outlook. Secular learning was discouraged. Islamic dogma was linked with Sufi mysticism. The Shariah came to dominate Muslim life as the Torah had dominated post-exilic Judaism. Door was closed against further borrowing from outside; philosophy repudiated, rigidity introduced."[1]

Dr. I. H. Qureshi analysing the causes of Muslim decline says: "The military strength of the West was

[1] History of Medieval Islam.

not an isolated factor. It was an expression of a general upsurge of the spirit of adventure and inquiry that had revived the West after a long period of inertia and backwardness. The Mongol invasions of the 13th century had destroyed so much in the Eastern lands of Islam that they were exhausted and prostrate. Material prosperity had gone because of the large scale destruction of the irrigation works which had been carefully constructed over a long period. As large areas of the devastate lands were arid the disappearance of the irrigation facilities was a great disaster. The educational institutions and the centres of learning were annihilated, scholars dispersed and books destroyed, thus drying up the sources of Muslim intellectual activity. In short, when the West started on its career of progress, the Muslim East began to sink in inertia. The old curiosity the mother of all intellectual progress, was gone. Thus, even if there had been no psychological barriers, there would have been little inclination to take a goo look at Western sciences and then to participate once again in the grand activity of broadening the horizons of human knowledge. The impact of the West could have acted as a catalyst if the Muslim intellectual circles had been awaked and not dormant. As a matter of fact the tendency to ignore Western learning was as much the result of intellectual lethargy as of false pride. For when individuals and societies decide that they know enough, they start on the path of decay.

"The attitude of the Muslim scholars of those days resulted in the then existing educational institutions to go on with their old methods and static learning without taking any cognizance of the new additions to human knowledge. Hence, instead of participating in the intellectual development of the world they became museum pieces peddling knowledge that ceased to be of any use in the affairs of the world. However, because they alone imparted instruction in Islamic religious sciences, they continued to serve a purpose

and found support among the religious-minded and the pious sections of the community. This resulted in grave consequences for the Muslim peoples which are a matter of common knowledge."[1]

Max Meyerhof remarks, "Looking back we may say that Islamic medicine and science reflected the light of the Hellenic sun, when its day had fled, and that they shone like a moon, illuminating the darkest night of the European Middle Ages; that some bright stars lent their own light and that moon and stars alike faded at the dawn of a new day—the Renaissance. Since they had their share in the direction and introduction of that great movement, it may reasonably be claimed that they are with us yet".[2]

1. Ulema in Politics, pp. 14-15, Ma'arif Limited, Karachi, 1974.
2. Legacy of Islam, p. 354.

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